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Assessment of Measles Elimination Criteria in Shendi & Almatama Localities, River Nile State, Sudan 2015

A Research Dissertation Submitted For PhD Degree in Public Health

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الآيـــــــــــه

بسـم الله الرحمن الرحيم

قـــال تعالي

(فَاصْبِرْ كَمَا صَبَرَ أُوْلُوا الْعَزْمِ مِنَ الرُّسُلِ وَلا تَسْتَعْجِل لَّهُمْ كَأَنَّهُمْ يَوْمَ يَرَوْنَ مَا يُوعَدُونَ لَمْ يَلْبَثُوا إِلا سَاعَةً مِّن نَّهَارٍ بَلاغٌ فَهَلْ يُهْلَكُ إِلا الْقَوْمُ الْفَاسِقُونَ)

صدق الله العظيم

الأحقاف: 35

Dedication

It is my genuine gratefulness and warmest regard that I dedicate this work to

My mother and father,

My closer sister (Asia) who inspire me for this work,

My wife and my wonderful daughters and son and

To soul of my brother (Alwakil Basha)

....

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Abstract

Measles disease is considered as one of the most serious childhood diseases worldwide, Sudan started measles elimination activities since 2004 .Therefore, remarkable progress noted in morbidity and mortality reduction of the disease.

A descriptive cross sectional facility and community based study was carried out in Shandi and Almatama localities in River Nile state in Sudan during the period from November 2012 to February2015.

This study aimed to assess the ongoing activities concerning measles elimination including measles converge in routine program , supplementary immunisation activities ,surveillance system ,outbreak response and clinicians awareness .WHO standard of 30 clusters immunisation survey was applied for both localities to assess immunisation coverage through examine the immunisation status of 840 children. In addition, all surveillance sites of reporting system were selected in this study and the clinicians whom attending the hospitals during the period of the study were interviewed.

The study revealed that, measles's first dose coverage (MCV^1) was (93.8% - 91.9%) in Shendi and Almatama localities respectively, measles's second dose coverage (MCV^2) was (84.8% - 86.2%) in Shendi-Almatama localities respectively, the post measles SIAs survey coverage was (91.9% - 87.7 %) in shendi & Almatama localities, respectively comparing with (101% -98.7%) as administrative coverage. Moreover, educated mothers were more likely to have their children immunised than mothers who had no education, and rural areas had the highest coverage rates compared with urban and slum areas.

This Study showed high sensitivity in surveillance reporting system noted in both localities and they were added numbers of private clinics in order to extend the surveillance network, conversely, very poor community link in surveillance activities in both localities. Moreover, an

Outbreak reports was not available in locality level as well as absence of any evidence of analysing or displaying data.

In conclusion ,the study recommended that, National immunisation program should conduct a periodic immunisation surveys especially in high risk groups To obtain high level of first and second doses of measles coverage as well as focus on improving the quality of supportive supervision with proper teams selection and data quality management. Furthermore, Regular and systemic training process needed to enhance the clinician's awareness in focus on House officers groups.

المستخلص

يعتبر مرض الحصبه من أخطر أمراض الطفوله في العالم ,بداء السودان انشطه القضاء علي مرض الحصبه من ذ العام 2004 مما ادي الي تطور ملحوظ في تقليل نسبه المراضه والاماته من مرض الحصبه.

أجريت هذه الدراسه الوصفيه المقطعيه من المجتمع والوحدات الصحيه في محليتي شندي والمتمه بولايه نهر النيل بالسودان ,في الفتره من نوفمبر 2012م وحتي فبراير 2015م .

هذه الدراسه تهدف الي تقييم انشطه القضاء علي مرض الحصبه التي تتكون من تغطيه الحصبه للجرعه الاولي والثانيه في برنامج الروتين وتغطيه الجرعه الاضافيه للحملات ,نظام الترصد ,التصدي الفاشيات ووعي المعالجين .طبقت عينه ال30 عنقود المعياريه لمنظمه الصحه العالميه بالمحليتين وذلك لتقييم التغطيه التمنيعيه وقد تم مسح 840 طفل وزياره كل مراكز الترصد للحصبه ومقابله المعالجين بالمستشفيات اثناء فتره جمع المعلومات .

خلصت الدراسه الي ان تغطيه الحصبه للجرعه الاولي كانت (91.9% - 93.8%) والتغطيه للجرعه الثانيه - 84.8%) (86.2% بمحليتي شندي والمتمه . وقد كانت تغطيه جرعه الحصبه الاضافيه (87.7 % - 91.9%) بالمحليتين مقارنه (98.7% -101%) التغطيه الفعليه بالمحليتين . اتضح ان الامهات المتعلمات اكثر اهتماما باخذ اطفالهن للتطعيم من الامهات الغير متعلمات ومناطق الحضر اظهرت تغطيه اعلي من مناطق الريف والسكن الغير منظم.

هذه الدراسه اظهرت ايضا حساسيه عاليه في نظام تقارير الترصد في المحليتين وقد تمت اضافه العيادات الخاصه لتوسيع شبكه عمل الترصد . وبالنقيض كان هنالك ضعف في الارتباط مع المجتمع تجاه انشطه الرصد والتقصي بالمحليتين اضافه الي عدم وجود تقارير تفشيات الحصبه او اي تحليل او عرض للبيانات .

في الختام اوصت الدراسه الي ان علي برنامج التحصين الموسع الاتحادي تطبيق مسوحات دوريه لتقييم التغطيه خاصه في المناطق الخاصه وذلك لضمان تغطيه عاليه للجرعه الاولي والثانيه ,بجانب ذلك يجب التركيز علي تحسين جوده الاشراف الداعم ,اختيار الاتيام وجوده استخدام البيانات .ايضا يجب عمل دورات مستمره ومنتظمه لرفع وعي المعلجين تجاه القضاء علي المرض وذلك بالتركيز علي شريحه اطباء الامتياز .

Abbreviation

AMR	Regions Of America
BCG	Bacilli Calmett And Gurine
CDC	Centre For Disease Control And Prevention
CRS	Congenital Rubella Syndrome
DPT	Diphtheria Pertuses And Tetanus
EMR	Eastern Mediterranean Region
EPI	Expanded Program Of Immunisation
EUR	Europe Region
M &R	Measles and Rubella
MCV1	Measles Coverage Vaccine First Dose
MCV2	Measles Coverage Vaccine Second Dose
MDGS	Millennium Development Gaols
MLIs	Measles Like Illness
MMR	Measles, Mumps And Rubella
MMWR	Morbidity And Mortality Weekly Report
MV	Measles Vaccine
NNDSS	National Notifiable Diseases Surveillance System
PCV	proportion of cases occurring in vaccinated individuals
PPV	proportion of the population that is vaccinated
SIAs	Supplementary immunisation activities
SSPE	Subacute Sclerosing Panencephalitis
UNICEF	United nations Children Fund
VE	Vaccine efficacy
WHO	World Health Organization
WRP	Western Pacific Region.

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Introduction

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Introduction

1.1 Introduction

Measles is one of the most infectious and severe diseases of childhood and remains an important cause of morbidity and mortality in children in developing countries. In recent years, with the support of WHO and UNICEF, countries have accelerated their efforts to reduce measles morbidity and mortality both through increasing routine measles coverage and conducting periodic supplementary immunization activities (campaigns). In the period 2000–2007, these accelerated measles activities led to a 74% reduction in estimated global measles mortality (90% in the Eastern Mediterranean and 89% in the African regions). In addition, high coverage of two doses of measles vaccine (delivered through routine programs with or without supplementary campaign strategies) has virtually eliminated measles from the western hemisphere since November 2002.

The current goals in the six regions for measles are elimination in the regions of the Americas (AMR), Eastern Mediterranean (EMR), Europe (EUR) and Western Pacific (WPR) and, mortality reduction in AFR. Due to the success of the measles mortality reduction and elimination efforts thus far through the Measles Initiative and related WHO-UNICEF efforts, WHO has raised the question of feasibility of possible new goals such as the eradication of measles or further significant reductions in measles mortality [(1)].

The fourth Millennium Development Goal (MDG 4) aims to reduce the under-five mortality rate by two-thirds between 1990 and 2015. Recognizing the potential of measles vaccination to reduce child mortality, and given that measles vaccination coverage can be considered a marker of access to child health services, routine measles vaccination coverage has been selected as an indicator of progress towards achieving MDG 4 [(2)].

Intensified efforts to vaccinate children against measles have resulted in a 74% drop in global measles-related deaths between 2000 and 2010, from an estimated 535,000 down to

139,000 [3]. Despite the significant drop in measles deaths since 2000, there is more work to be done to ensure that children are protected. In 2007, more than 23 million one-year old children did not receive a dose of measles vaccine through routine immunization services [4]. Moreover, in 2006, South Korea became the first country in (WPR) to declare measles elimination [5]. United States considered the largest country to have ended endemic measles transmission. This experience provides evidence that sustained interruption of transmission can be achieved in large geographic areas, suggesting the feasibility of global eradication of measles [6].

In Sudan, several measles outbreak were reported before introducing the vaccine in 1985, and measles was considered as one of the morbidity and mortality cause among under five years, after starting measles elimination strategies in 2004, dramatically decreasing of morbidity and mortality of measles cases were reported because of conducting SIAs and increasing in routine immunisation activities. During 2004, 2005 the number of cases were 10131, 1374, while only 228 cases were reported in 2006 (95% reduction from 2004) .Sudan also experienced several outbreaks in different regions because of accumulation of susceptible population [7].

1.2 Problem statement

Measles elimination is the situation in a large geographical area in which endemic transmission of measles has stopped and sustained transmission does not occur following the occurrence of an imported cases, the other definition is the status of measles elimination is best summarized by evaluation of the effective reproduction number R; maintaining $R < 1$ is necessary and sufficient to achieve elimination [8]. WHO also defined measles elimination as (Measles elimination is defined as the absence of endemic measles cases for a period of >12 months, in the presence of adequate surveillance. One indicator of measles elimination is a sustained measles incidence of <1 case per million population) [9].

While measles is now rare in many industrialized countries, it remains a common illness in many developing countries. Globally, more than 30 million people are affected each year by measles. In 2004, an estimated 454,000 measles deaths occurred globally; this translates to more than 1,200 deaths every day or 50 people dying every hour from measles. The overwhelming majority (more than 95%) of measles deaths occur in countries with per capita gross national income of less than US $1,000. In countries where measles has been largely eliminated, cases imported from other countries remain an important source of infection.

The WHO/UNICEF Measles Mortality Reduction and Regional Elimination Strategic Plan, 2001-2005 outlines the following strategies for reducing measles mortality:-

- providing the first dose of measles vaccine to successive cohorts of infants95%
- Ensuring that all children have a second opportunity for measles vaccination95%
- Enhancing measles surveillance with integration of epidemiological and laboratory information;
- Improving the management of every measles case [10].

Achieving measles elimination in countries depends on having high quality SIAs, improvements in routine immunization, and good surveillance in place. In addition, an assumption was made that case importation would decrease. Thus, the incremental costs of achieving elimination were associated with the costs of improving the quality of SIAs, routine immunization and surveillance. The costs of increasing routine immunization coverage and finding harder-to-reach cases were assumed to be increasing and the rate of increase is greater at higher levels of coverage. In addition, costs per dose of SIAs are assumed to increase by approximately $0.01 per additional percentage of coverage. These increasing costs are not so high as to make eradication economically unattractive [11]. Reaching the measles elimination goal by the target date of 2010 will require high-level political commitment to increase and sustain at high levels 2-dose MCV coverage among children and, where necessary, implement SIAs to reduce measles susceptibility among older cohorts [12].

The resources provided by the Measles Initiative partners have been pivotal in priority countries that had the highest burden of measles in 2000. The Initiative secures the financial resources required to implement activities through joint resource mobilization efforts. In 2009, the Initiative provided more than US$ 20 million for measles campaigns and surveillance in 32 countries. Since its inception, over US$ 693 million has been devoted to measles control through the Initiative [13].

In Sudan, Measles considered the third cause of infant mortality and the first cause of mortality among vaccine preventable disease**s.** Prior the introduce of vaccine in 1985,the country experienced nationwide outbreaks on a regular basis of 50 to 75000 cases and 1500 to 30000 death annually .there has been considerable decrease in disease incidence as vaccination coverage has increased .approximately 40% of patient with acute disease are in the age group between 5 to 15 years of age [14].

1.3 Rationale

The rationale of this study is, measles elimination considered as one of the WHO priorities for elimination by 2015 and the present study aim to assess elimination activities and no previous study has done in shendi & Almatama locality. Additionally, the university`s mission is to serve in the local community to improve the quality of their life.

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1.4 .Objectives

1.4.1. General objective

To assess Measles Elimination Criteria in Shendi & Almatama localities, River Nile State, Sudan 2013-2015.

1.4.2. Specific objectives

- To identify measles surveillance performance criteria according to WHO standards.
- To identify the universal Measles first dose coverage (MCV^1) and Measles second dose coverage (MCV^2).
- To determine supplementary immunisation activities (SIAs) in term of quality and coverage for measles elimination.
- To determine socio-economic factors limiting immunisation intake.
- To study measles epidemiological changes and outbreaks in term of distribution and interventions.
- To assess the clinicians awareness regarding measles elimination activities.

Chapter (2)

Literature review

Chapter (2)

Literature review

2.1 Introduction

Measles is an acute viral disease caused by a paramyxovirus of the genus *Morbillivirus*. Symptoms include fever, cough, runny nose, red eyes and a generalized maculopapular erythematous rash. It is spread by respiratory system contact with fluids from an infected person's nose and mouth by either droplet (coughing or sneezing) or aerosol transmission. Although a vaccine has been available since 1959, measles remains an important cause of morbidity and mortality in children, particularly in developing countries where more than 95% of measles-associated deaths occur. Measles vaccination efforts have achieved major public health gains, resulting in a 74% decline in measles deaths worldwide between 2000 and 2007 from an estimated 750, 000 to 197, 000, with a decline of about 90% in the eastern Mediterranean and sub-Saharan African regions (15).

Measles is an important public health concern during disasters involving massive population displacements who end up living in camps. The World Health Organization (WHO) recognizes refugees as one of the high-risk groups for measles outbreaks. Several outbreaks have been reported among refugees and other emergency settings due to their characteristic massive population displacements, overcrowding, high population densities and low vaccination coverage. Overcrowding is associated with the transmission of higher infectious doses of measles virus, resulting in more severe cases of clinical disease, which makes measles more often the leading cause of mortality among children in refugee populations (16).

If moderate immunization coverage results in low numbers of cases, the extra resources to reach elimination may seem hard to justify. However, with only moderate coverage, there will eventually be a large measles epidemic through the build up of susceptible. Such epidemics are likely to have a disproportionate impact because health services are no longer used to deal with measles, and there will be many cases and a greater proportion of cases will be in older children and young adults. It is clear that elimination is the only Appropriate option (unless one accepts pre-vaccine measles morbidity and mortality) [17].

Global measles mortality has decreased by 78% from an estimated 733,000 deaths in 2000 to an estimated 164,000 deaths in 2008. Even the current reduced rate of 450 deaths a day, 300 of which occur in India, is still hundreds too many, however, for a disease that can easily be prevented [17].

2.2 Measles epidemiology

2.2.1 Infectious agent

Measles virus is a member of the genus Morbillivirus of the Paramyxoviridae family. The virus appears to be antigenically stable. There is no evidence that the viral antigens have significantly changed over time. There is only one antigenic type, with a number of genotypes [18].However, sequence analysis of viral genes has shown that there are distinct lineages (genotypes) of wild-type measles viruses. When considered along with epidemiological information, identification of a specific virus genotype can suggest the origin of an outbreak. For instance, the genotype of the virus isolated during the 2001–2002 outbreaks in Venezuela was a close match to a virus isolated in cases imported into Australia from Indonesia as early as 1999. Vaccination protects against all wild-type genotypes. The measles virus is sensitive to ultraviolet light, heat, and drying [19].

The viral core is a pleomorphic ribonucleoprotein particle, consisting of the negative sense, non-segmented, single stranded RNA genome contained within a helical nucleocapsid . The genome consists of 15894 nucleotides, encoding six structural proteins [20].

2.2.2. Occurrence

Measles produces a significant amount of illness, death, and disability in developing countries. Measles caused approximately 7% of the estimated 11.6 million deaths that occurred in 1995 in children aged 4 years and under in developing countries. Of the estimated 614,000 measles-related deaths occurring in 2002, 312,000 (51%) and 196,000 (32%) were in Africa and South-East Asia, respectively [(21)].

Measles occurs worldwide in distinct seasonal patterns. In temperate climates, outbreaks generally occur in late winter and early spring. In tropical climates, transmission appears to increase after the rainy season.

In developing countries with low vaccination coverage, epidemics often occur every two to three years and usually last between two and three months, although their duration varies according to population size, crowding, and the population's immune status. Outbreaks last longer where family size, and hence the number of household contacts, is large. In the absence of measles vaccination, virtually all children will have been infected with measles by the time they are 10 years old [(22)].

Countries with relatively high vaccination coverage levels usually have five to seven year periods when case numbers remain small. However, if the number of susceptible persons becomes large enough to sustain widespread transmission, explosive outbreaks may occur. The introduction of measles vaccine in the Americas in the 1960s resulted in a marked decrease in the number of reported measles cases. The creation of the Expanded Program on Immunization (EPI) in 1977 and the ensuing increase in vaccination coverage, contributed to a further drop in the number of reported measles cases and a tendency toward longer intervals between epidemic years [(20)].

In 2011, the WHO estimated that there were about 158,000 deaths caused by measles - about 430 deaths every day. Mortality in developed countries is about 1 in 1,000 cases (.1%).

In populations with high levels of malnutrition and a lack of adequate healthcare, mortality can be as high as 10%. In cases with complications, the rate may rise to 20–30%.[54] According to the 2011 United Nations Millennium Development Goals report, "the combination of increased immunization coverage and the opportunity for second-dose immunizations led to a 78% drop in measles deaths worldwide. These averted deaths represent one quarter of the decline in mortality from all causes among children under five [(23)].

2.2.3. Transmission

Measles virus is transmitted primarily by respiratory droplets or airborne spray to mucous membranes in the upper respiratory tract or the conjunctiva. Common source outbreaks associated with airborne transmission of measles virus have been documented.

2.2.4. Reservoir

Humans are the only natural hosts of measles virus. Although monkeys may become infected, transmission among them in the wild does not appear to be a mechanism by which the virus persists in nature.

2.2.5. Incubation period

The incubation period is approximately 10–12 days from exposure to the onset of fever and other unspecific symptoms, and 14 days (with a range of 7–18 days, and, rarely, as long as 19–21 days) from exposure to the onset of rash.

2.2.6. Temporal Pattern

In temperate areas, measles disease occurs primarily in late winter and spring [(24)] .some study shows that the disease could spread through all the years' seasons but more so in winter and spring months [(25)].

2.2.7. Communicability

Measles can be transmitted from four days before rash onset (i.e., one to two days before fever onset) to four days after rash onset. Infectivity is greatest three days before rash onset. Measles is highly contagious. Secondary attack rates among susceptible household contacts have been reported to be 75%–90%. Due to the high transmission efficiency of measles, outbreaks have been reported in populations where only 3% to 7% of the individuals were susceptible. Whereas vaccination can result in respiratory excretion of the attenuated measles virus, person-to-person transmission has never been shown. medical setting have the focus of numbers of measles outbreaks it is paradoxical that the child health clinic the very place parents brings their children to protected against diseases, may became where child acquire disease (26) .study in coat devoir revealed that two third of measles case treated in health centre were nosocomial in origin (27).

All individuals who have not had infection or been effectively immunized or those with profound cellular immunosuppressant are susceptible. Immunity following natural infection is believed to be life long, and vaccination with measles containing vaccine has been shown to be protective for at least 20 years Vaccination protects against all wild-type genotypes. Infants whose biological mothers have had disease are generally protected until six to nine months of age or longer by passively acquired maternal measles antibody. Infants whose mothers have been immunized have lower levels of passive antibody and may have a shorter duration of protection (28).

Reasons for non vaccination identified through outbreak investigations during 2009--2010 in Afro region included vaccine unavailability; strict adherence to the WHO open vial policy, leading to batching of children into infrequent vaccination sessions; and exclusion of children aged >12 months, who were considered ineligible for MCV1. In addition, unwillingness to receive vaccination was identified among certain religious groups in Zimbabwe, Botswana, Malawi, and South Africa (29).

2.2.8. Risk for travellers

Travellers who are not fully immunised against measles are at risk when visiting countries or areas where vaccine coverage in complete .special attention must be paid to children and adolescent /young adult travellers who have not received two doses of measles vaccine [30] .

2.3 Changing epidemiology

Since the introduction of effective measles vaccines, the epidemiology of measles has changed in both developed and developing countries. As vaccine coverage has increased, there has been a marked reduction in measles incidence; and, with decreased measles virus circulation, the average age at which infection occurs has increased [31].

Even in areas where vaccine coverage rates are high, outbreaks may still occur. Periods of low incidence (the “honeymoon” effect) may be followed by a pattern of periodic measles outbreaks, with an increase in the number of years between epidemics. Outbreaks are generally due to the accumulation of persons susceptible to measles virus, including both unvaccinated persons and those who were vaccinated but failed to seroconvert. Approximately 15% of children vaccinated at 9 months of age and 5%–10% of those vaccinated at 12 months of age fail to seroconvert, and are thus not protected after vaccination.

After the introduction of measles vaccine during the 1960s, countries that had achieved high vaccine coverage experienced a 98% or greater reduction in the number of reported cases. However, periodic measles epidemics continued to occur, especially in large urban areas. These outbreaks occurred primarily among unvaccinated preschool- aged children, but cases and outbreaks were also reported among fully vaccinated school-aged children.

For instance, unvaccinated infants and preschool-aged children were at greatest risk for measles infection during the 2001–2002 outbreaks that occurred in Venezuela. Cases among older children and adults also occurred and likely involved those individuals who had not been vaccinated and had previously escaped natural measles infection because of decreasing measles incidence. Since measles vaccine is less than 100% effective, vaccinated individuals might also have contracted measles.

In large urban areas, even where measles vaccine coverage is high, the number of susceptible infants and children may still be sufficient to sustain transmission. Conditions such as high birth rates, overcrowding, and the influx of large numbers of susceptible children from rural areas can facilitate measles transmission.

In areas where measles remains endemic, a large proportion of cases occur in children aged less than 1 year, an age group that also has the highest age-specific measles case-fatality rates. In those areas, only a brief period (or "window of opportunity") exists between the waning of maternal antibody and children's exposure to circulating measles virus [(19)].

Outbreak investigations are important for measles control because studying outbreak epidemiology, in addition to studying individual measles cases, helps to understand patterns of measles virus transmission including who is susceptible and in which settings the disease spreads. This information is essential for refining strategies for measles prevention. Results of outbreak epidemiology strengthen the evidence for the absence of endemic transmission of measles along 4 lines of reasoning. First, actively searching for cases in response to the report of a single case contributes to the credibility of the data on measles incidence. When small outbreaks are identified, confidence increases in the system's ability to detect large outbreaks if they occurred [(32)].

2.4 Measles in Adults

Although measles usually is considered a childhood disease, people of any age can get it. In the, most cases are in unvaccinated infants, children, and teens. Adults at increased risk include college students, international travellers, and health care personnel [(33)].

Secondary failure of measles vaccine is a reason of measles outbreaks in young and adult population that is caused by decreasing anti measles antibody in the course of time. Secondary failure predisposes adults to measles infection if they have not been sub-clinically infected or have not had contact with measles virus before [34].

Measles infection or susceptibility in adults has serious consequences for children. First, infected adults are unable to work and could not adequately care for their children for a median of 15 days. Second, infected adults transmitted measles virus to susceptible children. Third, susceptible mothers could not confer protective anti-measles virus antibodies to newborn children, leaving them vulnerable to measles infection from their parents, siblings or other close contacts [35].A vacation period and an immunization campaign limited the spread of measles within the schools but could not prevent further spread among unvaccinated family members. It was necessary to raise clinicians' awareness of measles since it had become a rare, less known disease and went undiagnosed [36] .

A routine second dose of MMR vaccine, administered a minimum of 28 days after the first dose, is recommended for adults who:

- are students in postsecondary educational institutions;
- work in a health care facility; or
- Plan to travel internationally.

Persons who received inactivated (killed) measles vaccine or measles vaccine of unknown type during 1963–1967 should be revaccinated with 2 doses of MMR vaccine [37].

2.5 Risk factors for measles virus infection

Risk factors for measles virus infection include the following:

- Children with immunodeficiency due to HIV or AIDS leukaemia ,alkylation, or corticosteroid therapy, regardless of immunization status

- Travel to areas where measles is endemic or contact with travellers to endemic areas
- Infants who lose passive antibody before the age of routine immunization.

Risk factors for severe measles and its complications include the following:

- Malnutrition
- Underlying immunodeficiency
- Pregnancy
- Vitamin A deficiency [23].

Children at greatest risk of developing severe complicated measles include:

- The young, particularly those who are under one year of age.
- the malnourished (children with Marasmus or kwashiorkor)
- Those living in overcrowded situations (e.g. the urban poor, refugee camps) where they may be exposed to a high load of virus.
- Those whose immunity (the body's defence mechanism against infections) is affected, such as children with HIV infection, malnutrition or malignancy.
- Those who are vitamin A-deficient [38].

2.6 Clinical aspect of measles

During periods of high measles virus circulation, measles infection can be diagnosed clinically with reasonable accuracy. However, the large numbers of rash-like illnesses that may occur in childhood makes laboratory support the key to definitive diagnosis, especially during periods of low measles incidence [23].

Prodrome and general symptoms. Measles infection presents with a two to four day prodrome of fever, malaise, cough, and runny nose (coryza). Conjunctivitis and bronchitis are commonly present. Although there is no rash at the onset, the patient is shedding virus and is highly contagious. A harsh, non productive cough is present throughout the febrile period, persists for one to two weeks in uncomplicated cases, and is often the last symptom to disappear. Generalized lymphadenopathy commonly occurs in young children. Older children may complain of photophobia and, occasionally, of arthralgia [23].

Koplik's spots. Koplik's spots may be seen on the buccal mucosa in over 80% of cases, if careful daily examinations are performed shortly before rash onset. Koplik's spots are slightly raised white dots, 2–3 mm in diameter, on an erythematous base. Initially, there are usually one to five of these lesions, but as rash onset approaches there may be as many as several hundred. They have been described as resembling "grains of salt sprinkled on a red background." The lesions appear one to two days before rash onset and persist for two or three days, disappearing soon after rash onset [23].

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Rash. Within two to four days after the prodromal symptoms begin, a characteristic rash made up of large, blotchy red areas initially appears behind the ears and on the face. At the same time a high fever develops. The rash peaks in two to three days and becomes most concentrated on the trunk and upper extremities. The density of the rash can vary. The rash typically lasts from three to seven days and then fades in the same pattern as it appeared and may be followed by a fine desquamation. Whereas rash may be less evident in children with dark skin, desquamation generally is apparent. Some children develop severe exfoliation, especially if they are malnourished [23].

HIV-infected children with measles reported from the United States had no rash or a rash uncharacteristic of measles, and almost one-third died during the acute illness, most commonly of giant cell pneumonia [39].

2.6 Differential diagnosis

Regarding case-finding activity, many conditions produce rash syndromes that could be measles—for example, rubella, scarlet fever, dengue fever, and drug reactions. Although the incidences of these illnesses vary over time and by location, some level of diagnostic activity or investigation of measles like illness (MLIs) should be occurring regardless of the incidence of measles itself, and this activity can serve as a measure of case-finding effort [(40)]. And the early stages of chickenpox in the differential diagnosis. Moreover, there are other conditions that may present in a similar form, including erythema infectious (fifth disease), enterovirus or adenovirus infections, Kawasaki's disease, toxic shock syndrome, rickettsial diseases, and drug hypersensitivity reactions.

Modified forms of measles, with generally mild symptoms, may occur in infants who still have partial protection from maternal antibody, and occasionally in persons who only received partial protection from the vaccine. Atypical forms may occur in persons who were vaccinated with a formalin-inactivated (killed) vaccine, but such a vaccine has not been used since the mid-1960s. Case-based reporting and laboratory confirmation of every suspected case is fundamental for monitoring measles virus during the elimination phase. Regarding case-finding activity, many conditions produce rash syndromes that could be measles—for example, rubella, scarlet fever, rosella, dengue fever, and drug reactions. Although the incidences of these illnesses vary over time and by location [(40)].

Children aged less than 5 years and adults over 20 years of age are at greater risk of serious complications; malnutrition and immunodeficiency disorders also increase that risk. It was estimated that among the cases reported in the United States between 1987 and 2000, diarrhoea occurred in 8% of cases, otitis media in 7%, and pneumonia in 6%. Overall, 29% of the cases had some type of complication [(41)].

Respiratory infections.. Pneumonia is the most common severe complication from measles and is associated with the greatest number of measles-related deaths. It may be due to the measles virus alone or to secondary infection with adenoviruses or bacterial organisms [(41)].

Diarrhea and malnutrition. Diarrhea may develop both during and following acute measles illness, and is an important component of the burden caused by measles for children in developing countries. Measles infection is more severe among children who are already malnourished,. Under nutrition may lead to or worsen vitamin A deficiency and keratitis, resulting in a high incidence of childhood blindness following measles outbreaks [41].

Neurological complications. These occur in 1 to 4 of every 1,000 infected children. The most common manifestation is febrile seizures, which are not usually associated with persistent residual sequelae. Post infectious encephalomyelitis occurs a few days after rash onset in 1 to 3 of every 1,000 infected persons, especially in adolescents and adults. It may develop several years after a measles infection [41].

Case-fatality. In industrialized countries, the case-fatality rate for measles is approximately 1 per 1,000 reported cases. In developing countries, the case-fatality rate has been estimated at between 3% and 6%; the highest case-fatality rate occurs in infants 6 to 11 months of age, with malnourished infants at greatest risk. These rates may underestimate the true lethality of measles because of incomplete reporting of outcomes of measles illness, such as deaths related to chronic diarrhea that occur after the acute illness has passed. In addition, some deaths may be missed when death certificates are miscoded or hospital records are incomplete. In certain high-risk populations, case-fatality rates as high as 20% or 30% have been reported in infants aged less than 1 year. Young age, crowding, underlying immunodeficiency, vitamin A deficiency, and lack of access to medical care are all factors leading to the high case-fatality rates observed in developing countries [41].

Measles has been hypothesized to cause or contribute to multiple sclerosis, but available evidence is weak and inconclusive. Measles or measles vaccines have been suggested to contribute to or induce autism [42] . In addition to standard precautions, hospitalized patients should be cared for using airborne precautions until 4 days have passed since the onset of the rash (or for the duration of illness if the patient is immunocompromised) [43].

2.7 Measles vaccines

The original measles vaccines approved for use in children in 1963 were either inactivated (killed) or attenuated live virus vaccines. These vaccines are no longer in use. The vaccines currently employed in most countries are further-attenuated live measles virus vaccines, which are generally derived from the original Edmonston strain. The Moraten strain vaccine is used principally in the United States, while the Schwartz strain is the predominant vaccine used in many other countries.

All vaccine preparations containing standard titers of live measles virus may be used. The combined measles-mumps-rubella (MMR) vaccine is preferred to ensure that immunity is obtained against all three viruses. The use of MMR vaccine in measles campaigns will result in the reduction of rubella and mumps circulation among children and decrease the incidence of congenital rubella syndrome (CRS).

Programs that add rubella vaccine to their schedule should develop a complementary comprehensive rubella control plan to ensure that women of childbearing age and men are also protected against rubella.

Immunity. Serologic studies have demonstrated that measles vaccines induce seroconversion in about 95% of children aged 12 months or older, i.e. children who have lost all passively acquired maternal measles antibody. Although antibody titers are lower, the development of serum antibodies following measles vaccination mimics the response following natural measles infection. The peak antibody response occurs six to eight weeks after natural infection or vaccination. Immunity conferred by vaccination against measles has been shown to persist for at least 20 years and is thought to be life-long for most individuals. For combined vaccines, studies indicate that the antibody response to all antigens is equivalent to the response when each is administered separately.

The vaccine efficacy VE depended on sex and the sequence of vaccinations. The VE of measles vaccine MV against hospitalization for measles was better for girls than for boys.

Among children who had received MV as the most recent vaccine VE against hospitalization was as high as 96% for girls, but only 81% for boys (P _ 0.002) [44].

2.8. Contraindications to measles vaccine

Measles vaccine is contraindicated for:

- People who have cell-mediated immune deficiencies
- Pregnant women
- Those who had a severe allergic reaction to a vaccine component after a previous dose
- Those with moderate or severe acute illness
- Those who have recently received immune globulin products [45].

Malnutrition is not a contraindication, but rather a strong indication for measles vaccination. If a malnourished child is infected, the disease may aggravate his/her nutritional status and increase the chances of complications or death..

Adverse Events Associated with Vaccination. Adverse events range from pain and in duration at the injection site to rare systemic reactions such as anaphylaxis. They tend to occur among people who have never been vaccinated before, and are very rare after revaccination. Adverse events relate to the single component vaccines.

Approximately 5% to 15% of infants vaccinated with measles vaccines may develop a low-grade fever beginning 7–12 days after vaccination and lasting for one to two days; approximately 5% develop a generalized rash beginning 7–10 days after vaccination and lasting for one to three days. These reactions are generally mild and well tolerated. Neurological complications following vaccination are reported to occur in less than 1 in 1 million vaccines. The benefit of using the vaccine clearly outweighs the costs associated with having the disease, both in human and monetary terms.

2.9 Vaccine Efficacy and Effectiveness

Vaccine efficacy may be defined as how well a vaccine performs under the idealized conditions of a pre-marketing evaluation or a controlled clinical trial. Vaccine effectiveness, on the other hand, is considered to be the ability of a vaccine to provide protection under the normal conditions of a public health vaccination program. Since no vaccine is 100% effective, not all persons given measles vaccine is necessarily protected against measles. Therefore, following an importation of the measles virus or during a measles outbreak the occurrence of measles cases among persons with documentation of measles vaccination is to be expected. If vaccination coverage is high, a significant number of cases may occur among vaccinated persons. The occurrence of measles cases in these persons often leads to doubts about the effectiveness of measles vaccine. Several approaches can be used to estimate vaccine effectiveness. They include prospective cohort trials and case-control studies as part of an outbreak investigation. These methods are time-consuming and their discussion is beyond the scope of this guide. However, an alternative method has been developed which allows a rapid estimation of vaccine effectiveness when the proportion of cases occurring in vaccinated individuals (PCV) and the proportion of the population that is vaccinated (PPV) are known [42]. Low effectiveness levels, generally below 80%, may indicate problems with either the production of the vaccine or the cold chain. While this method does not provide an exact estimate of vaccine effectiveness, it allows health authorities to assess whether further evaluation is necessary [46].

2.10 Supplementary immunisation activates

SIAs generally are carried out using two approaches. An initial nationwide catch-up SIA targets all children aged 9 months to 14 years; it has the goal of eliminating susceptibility to measles in the general population. Periodic follow-up SIAs then target all children born since the last SIA. Follow-up SIAs generally are conducted nationwide every 2–4 years and generally target children aged 9–59 months; their goal is to eliminate measles susceptibility that has developed in recent birth cohorts and to protect children who did not respond to the first measles vaccination. The exact age range for follow-up SIAs depends on the age-specific incidence of measles, coverage with 1 dose of measles-containing vaccine, and the time since the last SIA [9].

2.11 Measles elimination in Eastern Mediterranean Region EMRO

In 1997, the 22 countries in the World Health Organization (WHO) Eastern Mediterranean Region (EMR) had resolved to eliminate measles from their region by 2010, The Eastern Mediterranean Regional strategy to eliminate measles calls for:

- Achieve and sustain >95% coverage with measles containing vaccine through high-quality routine immunization services at National and district level;
- Provide a second opportunity for measles immunization to susceptible groups;
- Strong case-base surveillance with laboratory confirmation; and
- Clinical management of measles cases.

Since then the Region has made substantial progress towards achieving measles elimination and reducing the burden of Measles disease. By 2008, measles deaths had decreased to 7000 deaths from 96 000 in 2000 a reduction of 93%. The number of confirmed measles cases decreased from about 88 000 in 1998 to 11 295 in 2011. The goal of the WHO–UNICEF Global Immunization Vision and Strategy (GIVS), achieving 90% reduction of measles mortality by 2010 compared to 2000 levels, was achieved three years before the target date.

All countries have implemented the nationwide catch-up campaign. Approximately 400 million people in the Region have been vaccinated through supplementary immunization activities since the elimination target was established. Maintaining immunity through high vaccination coverage levels is essential to eliminate measles and limit the spread of measles from imported cases [17].

2.12 Measles Elimination in Africa

In 2003, the World Health Assembly endorsed a global goal to reduce measles mortality by 50% by 2005, compared with the mortality in 1999. Through measles control strategies that included increasing routine immunization coverage and mass vaccination campaigns, the goal was achieved, and a new goal was established to achieve 90% reduction by 2010, compared with the mortality in 2000.

The WHO-recommended strategy for measles control in Africa, established in 2001, includes the following components:

1. Increasing routine vaccination coverage with the first dose of measles-containing vaccine (MCV1) for all children,
2. Providing a second dose of MCV to be given through supplemental immunization activities (SIAs),
3. Improving measles case management, and
4. Establishing case-based surveillance with laboratory confirmation for all suspected measles cases [(42)].

The SIA improved both coverage and equity, achieving significantly higher coverage in all provinces with routine measles vaccination coverage less than 80%, reached a large percentage of zero-dose children in these provinces, and reached more children belonging to the poorest households [(47)].

During 2001–2008, routine measles vaccination coverage in Africa increased from 54% to 73%, and approximately 400 million children were vaccinated during SIAs, resulting in a decrease in estimated measles mortality from 395,000 deaths in 2000 to 28,000 in 2008, a 92% reduction. In 1999, as part of the measles mortality reduction strategy, case-based surveillance with laboratory testing for all suspected measles cases was introduced. By 2009, all African countries except Algeria, Comoros, Guinea Bissau, Mauritius, Sao Tome & Principe, and Seychelles had established measles case-based surveillance in accordance with the WHO

African Regional Office measles surveillance guidelines. In 2009, WHO African member states endorsed a goal of .98% reduction in measles mortality by 2012, compared with mortality in 2000 and an additional goal of regional measles elimination by 2020 was adopted [48].

2.13 Measles in Sudan

Sudan is the largest country in Africa, located in the northeast. Measles is an endemic disease in Sudan. It is the third common cause of childhood deaths, preceded by gastroenteritis and non-specific fever. The incidence of the disease is greatly underestimated due to the general instability of the population; influx of immigrants from other countries, and the spread of wrong beliefs of not taking measles patients to hospitals. In 2001 the number of reported measles cases in Sudan was 4362. These reported incidence rates are all hospital-based and do not reflect the real incidence in the community.

A number of epidemiological studies involving the morbidity rates and age of infection have been carried out in different parts of Sudan. These showed that most measles cases occur during the first five years of life. A community-based study was performed in a suburban area in Khartoum, and showed a seasonal pattern in Measles virus infection with incidence rates peaking during winter. The risk factors predisposing to severe disease were found to include malnutrition, poverty, overcrowding and poor sanitation [20] .

The most common long-term measles complications in Sudan are eye lesions, pneumonia and otitis media. Measles cases in Sudan are only clinically diagnosed as no serological or virological assays are performed at the community health care units or hospitals. In many cases patients with measles have no access to medical treatment [20].

The live attenuated Schwarz vaccine was introduced in Sudan in the late 1970s. In 1985 the Ministry of Health introduced countrywide measles vaccination at 9 months of age, through the expanded programme of immunisation (EPI) services. This resulted in a remarkable reduction in the incidence of measles. Despite these extensive efforts, low vaccination coverage and high incidences of vaccine failure were reported. Vitamin A supplementation in the early course of infection was found to reduce the frequency of complications and mortality and proved to enhance recovery from complications. Vitamin A is thus therapeutically administered to measles cases reporting to hospitals and health centres [20].

2.14 Measles elimination program in Sudan

Measles is third cause of infant mortality in Sudan and the first cause of mortality among vaccine preventable disease**s.** Prior the introduce of vaccine in 1985,the country experienced nationwide outbreaks on a regular basis of 50 to 75000 cases and 1500 to 30000 death annually .there has been considerable decrease in disease incidence as vaccination coverage has increased .approximately 40% of patient with acute disease are in the age group between 5 to 15 years of age [14].

In order to achieve the global and regional measles elimination target ,EPI program in collaboration with WHO,CDC and UNICEF has develop the national measles mortality reduction plan in 2003,the plan has been implemented in four phases ,the storages of this plan included :-

- **Keep up** routine infant immunisation program above 95%.
- Provision of second opportunity of measles immunisation 95%.
- One time catch-up campaign targeting children from 9 month to 15 years.
- **A flow-up campaign** 4-5 years later targeting the cohort of fewer than five borne after the first catch-up campaign [14].

2.15 Measles surveillance

2.15.1 Measles Surveillance objectives

Surveillance is ongoing systematic collection, analysis, and interpretation of outcome-specific data for use in planning, implementation, and evaluation of public health practice.

Disease surveillance is a critical component of measles control and elimination efforts and is used in the assessment of progress and in making adjustments to programmes as required.

Surveillance data are essential for:

- describing the characteristics of measles cases in order to understand the reasons for the occurrence of the disease and develop appropriate control measures;
- predicting potential outbreaks and implementing vaccination strategies in order to prevent outbreaks;
- monitoring progress towards achieving disease control and elimination goals;
- Providing evidence that, in countries with low measles incidence, the absence of reported cases is attributable to the absence of disease rather than Inadequate detection and reporting [(10)].

Surveillance and its objectives should evolve according to the stage of measles control at the mortality reduction stage:

- Monitoring incidence and coverage in order to assess progress (i.e. decreasing Incidence and increasing coverage);
- Identifying areas at high risk or with poor programme performance; describing the changing epidemiology of measles in terms of age, status and the intervals between epidemics [(10)].

2.15.2 Surveillance At the low incidence or elimination stage:

- Identifying high-risk populations;
- Determining when the next outbreak may occur because of a build-susceptible Persons, and accelerating activities beforehand;
- Determining where measles virus is circulating or may circulate (i.e. high-risk areas);
- A the performance of the surveillance system (e.g. reaction time for notification, specimen collection) in the detection of virus circulation or potential importation;

- Assessing the performance of the surveillance system (e.g. reaction time for notification, specimen collection) in the detection of virus circulation or potential importation;

2.15.2 Monitoring the accumulation of susceptible persons

The aim of a vaccination programme is to reduce the number of susceptible and to ensure that low levels of susceptibility are maintained thereafter. The susceptibility profile describes the distribution of susceptibility to measles within a population. It will vary by age and by population sub-group (e.g., ethnic or social group). Before a new vaccination programme is launched the age specific susceptibility profile should be established. In particular, vaccination campaigns can only be targeted effectively if the distribution of susceptible individuals in the population is known. There are 3 methods to assess the susceptibility profile of a population, availability of surveillance data are important for the last two methods:

- **Serological surveys.** The most direct way to estimate the susceptibility profile is through an age stratified serological survey, interpreting samples negative for measles IgG antibody as susceptible to measles.
- **Alternative methods using vaccine coverage and incidence data.** For a healthcare system with limited resources other methods of estimating the susceptibility profile can be used. These rely upon routine vaccine coverage and case notification data. In populations with little exposure to natural infection, the proportion susceptible can be estimated from age-specific data on vaccination status (proportions who have received no dose, one dose only, and two doses) and vaccination effectiveness.
- **Mathematical models.** Mathematical models simulate measles transmission in a population and those simulations can be used to determine the susceptibility profile.

2.15.3 Operationalzing Surveillance of Measles

The functions of measles surveillance are:

- Detecting and reporting cases and outbreaks;
- Collecting, consolidating and interpreting data;

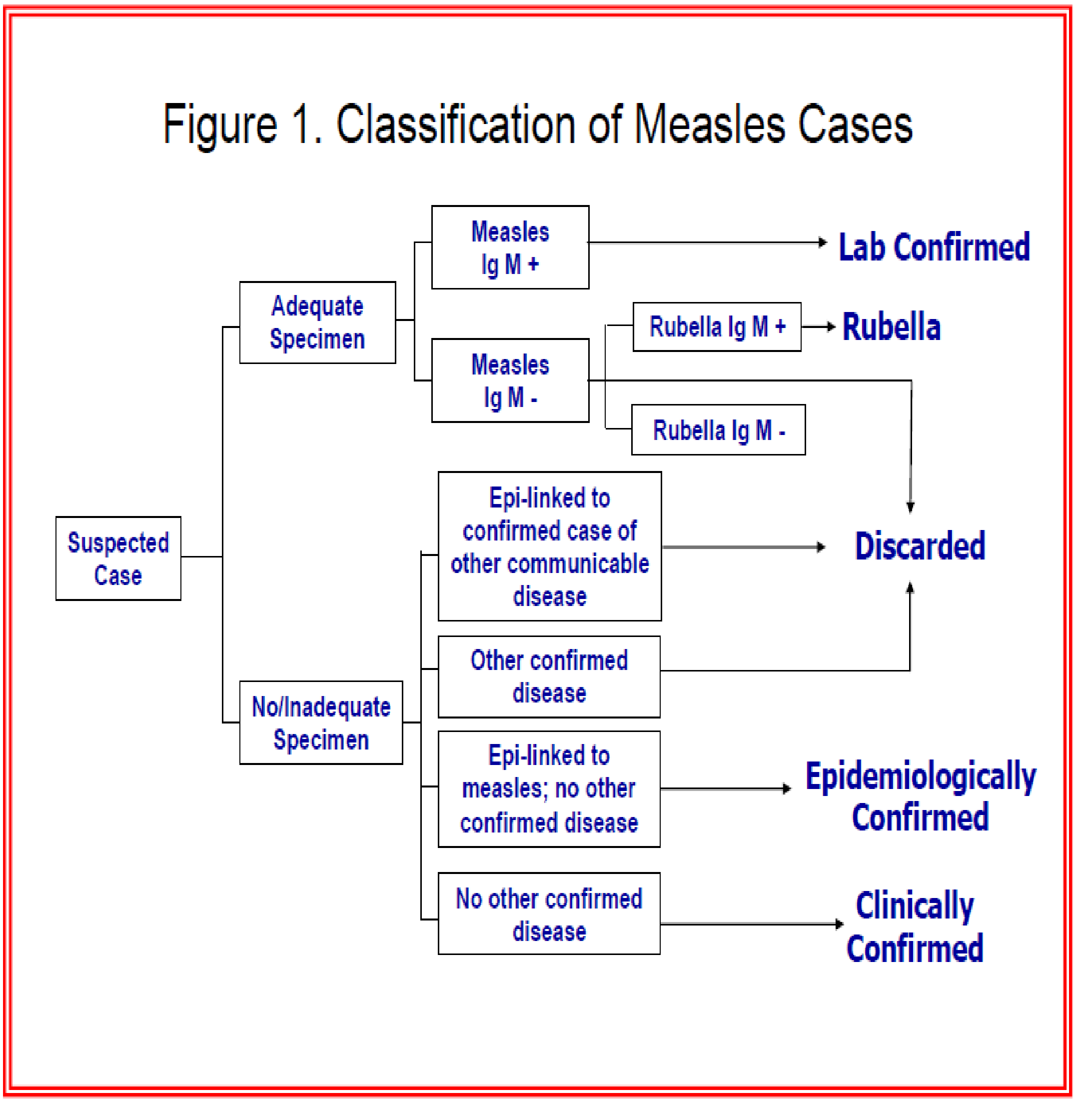
- Investigating and confirming cases and outbreaks;
- Analysing, producing routine reports and interpreting data;
- Feeding data forward to more central levels;
- Providing feedback to more peripheral levels (10).

2.12.3 Classification of Suspected Measles Cases

To calculate the indicators, it is necessary to understand how measles cases are classified. Currently, the WHO defines a suspected case of measles as any person satisfying the clinical case definition of fever and rash and one or more of the following symptoms: cough or coryza or conjunctivitis. As countries begin to target rubella for elimination, the suspected case definition may be changed to fever and rash illness to capture both measles and rubella. Ultimately, all suspected measles cases are classified as either confirmed or discarded. Cases may be confirmed by the laboratory, epidemiologic linkage, or clinically.

Classification of suspected measles depends on blood specimen collection and/or other diagnostic tests as well as epidemiologic investigation. Suspected cases are confirmed as measles if they are IgM positive or if they are epidemiologically linked to a laboratory or epidemiologically confirmed case. Epidemiologic linkage to measles occurs when there is contact with a lab confirmed or epidemiologically confirmed case 7–21 days before onset of rash in the suspected case. Suspected cases may be discarded as non-measles if adequate specimens are negative for IgM, and, for cases without adequate specimens, if they satisfy criteria for confirmation as a case of a different disease or are epidemiologically linked to a confirmed case of another communicable disease. Any suspected case that cannot be confirmed by the laboratory or by epidemiologic linkage and cannot be discarded is classified as a clinically confirmed case. As such, cases that are clinically confirmed represent a failure of the surveillance system to adequately investigate and classify cases of disease [(49)].

2.1.4 Classification of measles cases according to WHO criteria:-



2.16 Indicators for Monitoring Progress towards Measles Elimination

Extensive consultation among WHO and representatives of the global measles partnership including UNICEF and the U.S. Centres for Disease Control and Prevention has resulted in a consensus set of basic indicators for monitoring progress towards measles elimination. These indicators modify slightly those published in the Western Pacific Regional Office's Field Guidelines for Measles Elimination in 2004. Indicators of very low incidence, high quality surveillance, and high population immunity will be used by the Western Pacific Regional Office to monitor Regional progress towards measles elimination and will be evaluated periodically for their practicality and usefulness. Modifications will be made as needed in consultation with the global working group and the Western Pacific Regional Office TAG [(49)]. In its most common form, passive measles surveillance in the United States consists of several steps: The person with measles must seek health care, the health care provider must consider the diagnosis of measles and test the patient accordingly, and the health care provide must report the case to the local or state health department. The sensitivity of measles surveillance depends on each of these components [(50)].

2.16.1 Clinical case definition

An illness characterized by all of the following:

- A generalized rash lasting ≥3 days
- A temperature ≥101°F (≥38.3°C)
- Cough, coryza, or conjunctivitis

2.16.2 Laboratory criteria for diagnosis

- Positive serologic test for measles immunoglobulin M (IgM) antibody, or
- Significant (generally a fourfold) rise in measles antibody (lgG) level by any standard serologic assay, or

- Isolation of measles virus from a clinical specimen.

2.16.3 Case classification

Case classification requires a consideration of the clinical presentation.

- **Suspected:** Any febrile illness accompanied by rash.
- **Probable:** A case that meets the clinical case definition, has non contributory or no serologic or virologic testing, and is not epidemiologically linked to a confirmed case.
- **Confirmed:** A case that is laboratory confirmed or that meets the clinical case definition and is epidemiologically linked to a confirmed case. A laboratory-confirmed case does not need to meet the clinical case definition.
- **Imported-virus case:** A case for which an epidemiologic link to an internationally imported case was not identified, but for which viral genetic evidence indicates an imported measles genotype, i.e., a genotype that is not occurring within the United States in a pattern indicative of endemic transmission. An endemic genotype is the genotype of any measles virus that occurs in an endemic chain of transmission (i.e., lasting ≥12 months). Any genotype that is found repeatedly in U.S.-acquired cases should be thoroughly investigated as a potential endemic genotype, especially if the cases are closely related in time or location [(51)].

Monitoring of viral genotypes is an important component of measles surveillance and a tool to identify the likely source of imported viruses [(52)].

2.17 Recommended minimum data elements for surveillance

2.17.1 Aggregated data:

- Number of cases by age groups and immunization status
- Number of measles vaccine doses administered to infants aged under 12 months and children aged 12–23 months.

2.17.2 Case-based data:

- Unique identifier.
- Geographical area (e.g. district and province).
- Date of birth.
- Sex.
- Date of onset of rash.
- Number of prior measles vaccine doses received.
- Date of receipt of last dose.
- Date of notification.
- Date of case investigation.
- Date of blood specimen collection.
- Date blood specimen sent to laboratory.
- Date blood specimen received by laboratory.
- Condition of blood specimen .
- Date measles serology results reported.
- Results of measles serology.
- Results of differential serology (make separate variable for each disease):
- Specimen type
- Date specimen received for viral culture/identification.
- Results of measles viral culture/identification.
- Final classification:(a) clinically confirmed;(b) laboratory-confirmed;

(c) Epidemiologically linked to laboratory-confirmed case; (d) discarded.

- Source of infection identified.

2.18 Recommended data analyses, presentations, reports

2.18.1 Mortality reduction phase

- Number of cases and incidence rate by month and year, and geographical area
- Age-specific, sex-specific and district-specific incidence rates.
- Measles vaccine coverage by year and geographical area.
- DTP1–measles or BCG–measles dropout rate.
- Completeness/timeliness of monthly reporting.
- Proportion of known outbreaks confirmed by the laboratory.
- Proportion of cases by age group and immunization status. Core age groups suggested: 0–8 months, 9–11 months, 1–4 years, 5–9 years, 10–14 years, 15–19 years, 20–24 years, 25 years and over.

2.18. 2 Performance indicators Target

- % of weekly reports received ≥ 80%
- % of cases notified ≤ 48 hours after rash onset ≥ 80%
- % of cases investigated with house visit ≤ 48 hours after notification ≥ 80%
- % of cases with adequate specimen and laboratory results within 7 days ≥ 80%
- % of confirmed cases with source of infection identified ≥ 80%

2.18.3 Principal uses of data for decision-making

Monitor incidence and coverage to assess progress (i.e. decreasing incidence and increasing coverage) and identify areas at high risk or with poor programme performance. Describe the changing epidemiology of measles in terms of age, immunization status and interepidemic period. Assist in determination of optimal age groups to be targeted by second opportunity for measles vaccination (including mass vaccination campaigns).

Low-incidence or elimination phase: Identify chains of transmission. Monitor the epidemiology (age groups at risk, inter epidemic period, immunization status) of measles and accelerate immunization activities accordingly to avert potential outbreaks.

2.18.4 Special aspects

While IgM ELISA tests are more sensitive between days 4 and 28 after the onset of rash, a single serum sample obtained at the first contact with the health care system within 28 days after onset is considered adequate for measles surveillance.

If the case has been vaccinated within six weeks before serum collection, if an active search in the community does not find evidence of measles transmission and there is no history of travelling to areas where measles virus is known to be circulating, the case should be discarded [53].

2.19 World Health Organization Response (WHO)

The fourth Millennium Development Goal (MDG 4) aims to reduce the under-five mortality rate by two-thirds between 1990 and 2015. Recognizing the potential of measles vaccination to reduce child mortality, and given that measles vaccination coverage can be considered a marker of access to child health services, routine measles vaccination coverage has been selected as an indicator of progress towards achieving MDG 4 [2].

Overwhelming evidence demonstrates the benefit of providing universal access to measles and rubella-containing vaccines. Globally, an estimated 548 000 children died of measles in 2000. By 2011, the global push to improve vaccine coverage resulted in a 71% reduction in deaths. Since 2000, with support from the Measles & Rubella Initiative (M&R Initiative) over 1 billion children have been reached through mass vaccination campaigns about 225 million of them in 2011.

The measles and Rubella Initiative is a collaborative effort of WHO , UNICEF, the American Red Cross, the United States Centres for Disease Control and Prevention, and the United Nations Foundation to support countries to achieve measles and rubella control goals [2].

In April 2012, the M &R Initiative launched a new Global Measles and Rubella Strategic Plan which covers the period 2012-2020. The Plan includes new global goals for 2015 and 2020:

By the end of 2015

- To reduce global measles deaths by at least 95% compared with 2000 levels.
- To achieve regional measles and rubella/congenital rubella syndrome (CRS) elimination goals. By the end of 2020

- To achieve measles and rubella elimination in at least five WHO regions. The strategy focuses on the implementation of five core components:

- achieve and maintain high vaccination coverage with two doses of measles- and rubella-containing vaccines;
- monitor the disease using effective surveillance, and evaluate programmatic efforts to ensure progress and the positive impact of vaccination activities;
- develop and maintain outbreak preparedness, rapid response to outbreaks and the effective treatment of cases;
- communicate and engage to build public confidence and demand for immunization;
- Perform the research and development needed to support cost-effective action and improve vaccination and diagnostic tools [(2)].

Implementation of the Strategic Plan can protect and improve the lives of children and their mothers throughout the world, rapidly and sustainably. The Plan provides clear strategies for country immunization managers, working with domestic and international partners, to achieve the 2015 and 2020 measles and rubella control and elimination goals. It builds on years of experience in implementing immunization programmes and incorporates lessons from accelerated measles control and polio eradication initiatives [2].

The scale of required SIAs might be greater for countries that have suboptimal overall coverage, compared with those with pockets of susceptible persons but high overall coverage. Communication and education efforts to provide high-quality information on the safety of vaccines and to explain risks and benefits of vaccination are needed before implementation of SIAs, particularly in countries where safety concerns and religious or philosophical objections to vaccination are major challenges. In countries where underserved populations are the focus of remaining measles virus transmission, immunization efforts specifically targeting these groups, along with the measures to improve general access to health care, will be needed Implementation of SIAs in the European Region [54].

Criteria used in Australia for measles elimination declaration

- notified confirmed endemic case per million population since 2005 within an adequate surveillance system since 2004;
- consistently high two-dose vaccination coverage: MCV1 > 95% and MCV2 > 90% since 2004;
- serological evidence of population immunity > 90% since 2002;
- absence of an endemic genotype since 1999;
- a high proportion of cases imported or linked to an imported case since 1999;
- Containment of outbreaks without the re-establishment of a specific genotype since 1999; and
- Maintenance of an effective reproductive number for measles of < 1 since 1999. [55]

2.20 Measles outbreak control

Prompt immunization of all children at risk is a priority, to prevent further cases during an epidemic. It is not too late to immunize with measles vaccine even if children have been exposed to the virus and you think they are incubating the disease [56]. Immunize within three days of exposure and you may well prevent disease from developing. Large dose vitamin A supplements should also be given. Isolation of patients with measles from the rest of the population, while desirable, is extremely difficult in refugee camp settings [57].

Very few of the measles cases in these outbreaks are in people who are completely vaccinated. For example, in the outbreaks in Europe in 2011, when 30,000 people got measles, causing 8 deaths, 27 cases of measles encephalitis, and 1,482 cases of pneumonia, most cases were in unvaccinated (82%) or incompletely vaccinated people (13%) [58].

Chapter (3)

Methodology

Chapter (3)

Methodology

3.1 Type and duration of the study

The type of this study was a cross- sectional community and facility – based study in Shendi & Almatama localities, in the period (May 2012 - May 2015) to assess measles elimination criteria.

3.2 Study Area

Shendi & Almatama localities are part of River Nile state in North Sudan and they were one province in past, River Nile state bounded by Khartoum state to the south, northern state to the North, Gadarif state to the east and Kordufan state to the west .Shendi and Almatam localities are locating in the southern part of River Nile state they bounded by Aldamar locality to the North, Khartoum state to the South, Kassala state to the East and Northern Darfur state to the West .The total area of the tow localities is **76243** Km². The area of Shandi and Almatam localities divided to 347 catchment areas in EPI planning system including rural and urban site, each catchment area determined by borders and targets. The total estimated population is (454956) presented as (305931) for Shendi and (149025) for Almatam with total of (90991) households. As Topographical characteristic this localities lies on a flat mud-sandy area adjacent to the River Nile with few scattered mountains in the eastern part. These localities with an annual rainfall about 0 to 119 ml per year. They are situated in the main River Nile which provided water for agriculture land and the main harvested plants are cash crops like white beans onions and wheat.

Shendi Almatama localities consist of mixture various cultures that occur in Sudan thought the Northern tribes, Gaalien are predominant. The total population size is 454950 living in rural and urban areas, the illiteracy rate is high in villages, and the basic education consists of 232 schools in both localities.

The health system services divided this localities to eight administrative units are Wad Hamid , Alreef Alshmaly, Almatama, Maina Shendi, Shamal Shandi, Ganoob Shandi, Kaboshia and Hagar Alasal .The total numbers of health services providing immunisation services are 75 site and they represent the 3 basic immunisation strategies (fixed, outreach and mobile team) .these immunisation services are provided by total of 75 trained vaccinators .

The Disease surveillance system contain 12 sentinel site for reporting system and active search visit ,The sentinel sites are distributed as 5 sites in Almatama and 7 sites in Shendi locality .

3.3 Study Population

General Demographic information

Items	Shendi Locality	Almatama locality	Total
Total population	305931	149025	454956
Children <1year	9644	4698	14342
Children >9month to 15 years	116747	56870	173617
Children <5 years	44299	21579	65878
Children <15 years	122892	59863	182755
Estimated No of households	61186	29805	90991

1. **Children between 9 month to 15 years aged.**

Two children were selected from each household to evaluate the immunisation status by examining the immunisation cards or taking histories from caregiver recall, the state of two groups are:

- Child aged from 12 – 23 month during the time of immunisation survey were checked to assess MV1 & MV2.(Routine Immunisation)

- Child aged from 9 month to less than 15 years to evaluate the last SIAs campaign (measles campaign)

2. Focal persons of Disease surveillance in sentential sites.

All surveillance sites of reporting system were selected in this study (universal coverage) it was consisting of:-

- High priority sites
- Medium priority sites
- Low priority sites
- Community site surveillance.

3. EPI & surveillance officers

- EPI & surveillance officers at locality level.
- EPI & surveillance officer at administrative units' level.

4. Clinicians

- Clinicians whom attending the hospitals during the study period.

3.4 Sampling

WHO recommended 30-cluster EPI Coverage survey methodology was followed to assess immunization coverage in this study.

3.4.1 Sample size

- Total numbers of 30 clusters were randomly selected from each locality to complete 60 clusters (30 clusters from Shendi & 30 clusters from Almatama)
- From each cluster we selected 7 children aged (12 – 23 month) for first and second measles doses and 7 children aged (9 month to 15 years) to examine the last supplementary immunisation activities campaign .

- Total converge of sentinel surveillance sites (12sites) were visited including priority (high, medium &low) and WHO adapted structural questionnaire were used.
- Two EPI head office and operation officers including the surveillance officer.
- All clinicians working in the 3 hospital in both localities were selected during the period of the study.

Subject	Sample size	Note
Child 12 -23 month	210 + 210 = 420 Shendi +Almatama	Total of 840 Children
Child 9month – <15 year	210 + 210 = 420 Shendi +Almatama	
Sentinel site	12 reporting site	
EPI locality level(shendi & Almatama)	2	
Clinicians	27	Attending during the study period

3.4.2 Sample technique

WHO recommended 30-cluster sampling method was followed for the current Study to evaluate the immunisation status of the study groups.

A. Selection of the clusters

The catchment areas (Blocks or villages) list was obtained as sampling frame in order to select the 30 clusters for each locality. Then random simple sample was applied to select the 30 cluster from each locality and reserve list was devolved to provide option in case of any missing in the cluster like inaccessibility or community rejections.

B. Selection of the households (sample units)

- The first house visited in each cluster was selected at random using existing listings of household names, official maps, in case of the listing not available the map of the catchment area was used to determine the first house.
- Systematic random sample was applied for listed the households to select the 7 children for MV1 and 7 children for MV2. The sample interval was obtained by divided the total numbers of households over the number of child intend to select etc:

$$\textit{Sample interval} = \frac{\textit{total numbers of households in the cluster}}{\textit{7(number of sample unit)}}$$

- In areas where no listing for the households, the sketch map of the area was obtained and divided the catchment area into 4 sectors. Then, Random selection of one sector was applied, the data collectors stand at the centre of the sector and spin a bottle/pen and chosen the first house in the direction pointed as the starting point of the survey.
- The next or second household was selected by directing to right side and after count the number of sample interval.

Second households = first household + sample interval

C. Selection of eligible children (sample subjects)

Inclusion criteria:-

- Any child aged between 12-23 month (for routine immunisation) and 9month - <15 years (for measles campaign) living in the study area and took his/her vaccine shot inside the study area.

Exclusion criteria:-

- Any child coming from outside the study area and took his /her vaccine shot from outside or partially vaccinated in study area.
- Any child has measles vaccine sensitivity disease or has reasons for not completing the course.
- Any eligible child hasn't got person to give information about vaccine status during the time of data collecting should be discarded .(caregiver should the mother, father or any other family members up to 18 years)

3.5 Data collection

Data was collect by WHO adapted Structure questionnaires**.** Pretesting and Questionnaires validation was apply before the survey. The following four questionnaires and forms were used:

- Characteristics of households, mothers and all children aged 9 months through 15 years in each household included in the sample.
- Focal persons in sentinel site.
- Administrative units EPI operation officer.
- Locality EPI operation officer. .
- Clinicians.

3.6 Data analysis

All data collected from the questionnaires were coded, checked and cleaned before entering, and analysed by entering to computer using the statistical package for social science programme (SPSS).

Pilot study provides advice for the study as well as helps to identify possible problems and solution [59]. The pilot study was conducted by distributing the questionnaire to the parents in (*kawthar hara*) area (shendi locality) prior to the main study. Tables and figures used to present the results. The WHO standards cut-off was used to compare the elimination performance indicators in addition to significant tests like chi-square test.

3.7 Ethical clearance for the study

The survey conducted in accordance with the national policies on ethics for surveys involving human subjects. The proposal was passed by the faculty of public health and faculty of post graduate in Shendi University. The data collection started after taken consent from shendi locality health authority, Almatama locality health author and children caregiver .information of this study will be disseminated to the health authority in national, state and local level and in addition to published in local and international journals.

3.8 Study Limitation

The study met numbers of limitations .Firstly, unavailability of data about outbreak reports made our investigation about measles epidemiological changes very hard to monitor and we were not able to come out with the result as we plan in study objectives. Secondly, we were considering mother's recall to determine the history child immunisation's status that it might be as selection bias.

Chapter (4)

Results

Chapter (4)

Results

Table 1: Distribution by Resident site of the study population in Shendi & Almatam localities locality 2014.

Variables	Shendi	Almatama	Total	%
Urban	**102**	**26**	**128**	**30.5**
Rural	**91**	**105**	**196**	**46.7**
Semi Urban	**17**	**68**	**85**	**20.2**
Slum Area	**0**	**11**	**11**	**2.6**
Total	**210**	**210**	**420**	**100**

N = 420

Figure 1: Education level of the mothers in Almatama locality 2014.

N= 210

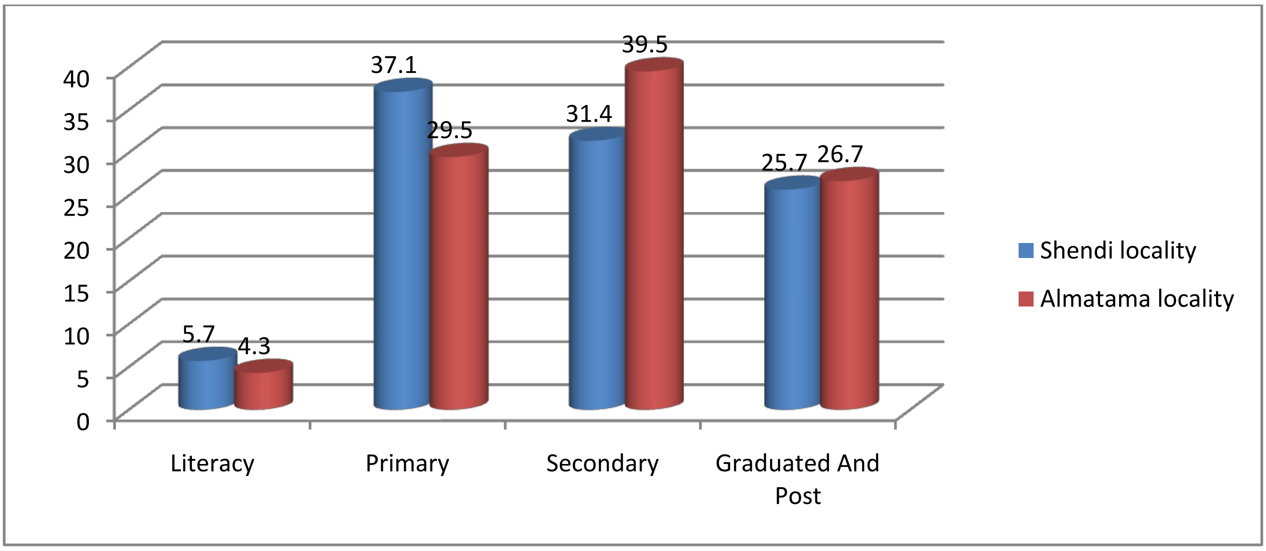


Figure (1) Shows that the educational level in shendi locality is most of mothers are in primary education (37.1%), secondary are (31.4%), (25.7%) are graduated and post graduate and 5.7 % illiteracy .in Almatama locality greater number is among secondary school 39.5%, primary 29.5% , graduate and post graduate 26.7%and 4.3%are literacy .

Figure 2: Income level of the study population in Shendi & Almatama localities 2014.

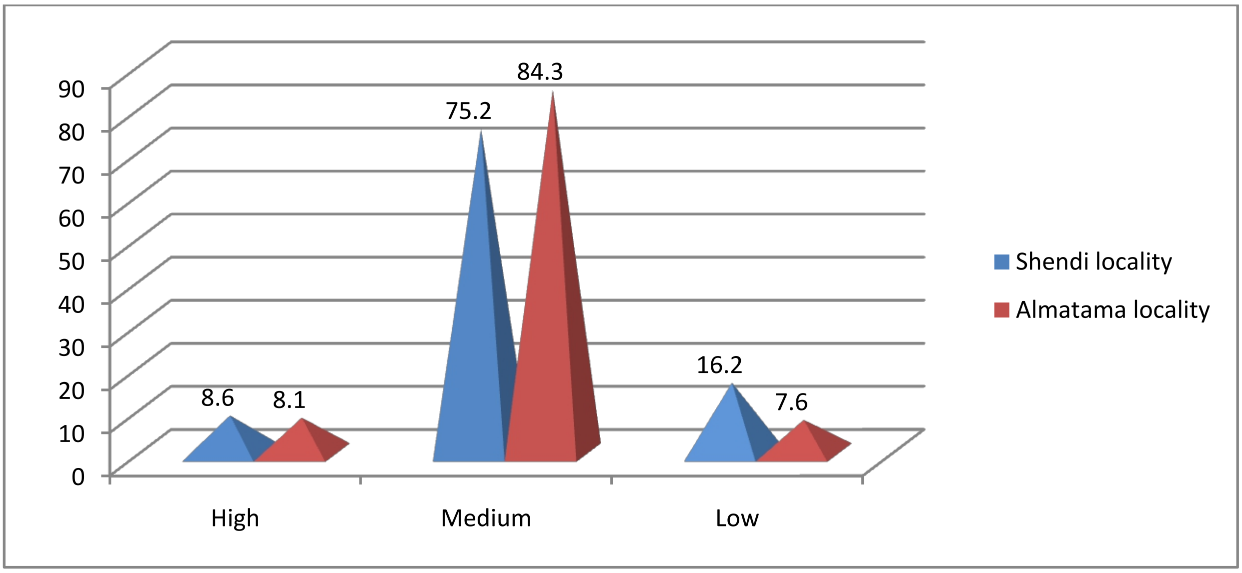


Figure (2) Shows that the income level in shendi locality is (75.2%).The medium income is (16.2%) and the low income is (8.6%) in Almatam (84.3%) is the medium level, 8.1% is high and 7.6% low income.

Table 2 : Number of children per household in Shandi & Almatam Localities locality2014.

Variables	Shendi	Almatama	Total	%
One Child	**33**	**14**	**47**	**11.2**
2-3 Children	**90**	**104**	**194**	**46.2**
4-5 Children	**62**	**77**	**139**	**33.1**
>5 Children	**25**	**15**	**40**	**9.5**
Total	**210**	**210**	**420**	**100**

N=420

Table 3: Availability of Immunisation cards among selected children in Shendi & Almatam localities 2014.

Variables	**Shendi**	**Almatama**	**Total**	**%**
Available	**178**	**167**	**345**	**82.1**
Not Available	**32**	**43**	**75**	**17.9**
Total	**210**	**210**	**420**	**100**

N=420

Table 4: The reasons of unavailability of immunisation cards among selected children in Shendi and Almatam localities 2014.

Variables	**Shendi**	**Almatam**	**Total**	**%**
Lost	**16**	**24**	**40**	**53.3**
Damage	**9**	**17**	**26**	**34.7**
Not Received	**7**	**12**	**19**	**25.3**
Total	**32**	**43**	**75**	**100**

N=75

Table 5: Age distribution among selected children for MCV1 in Shendi & Almatam localities 2014.

Variables	**Shendi**	**Almatam**	**Total**	**%**
<18 Months	**121**	**184**	**305**	**72.6**
≥18 - 23 Months	**89**	**26**	**115**	**27.4**
Total	**210**	**210**	**420**	**100**

N=420

Table 6: The converge survey of first dose of Measles vaccine among children Aged 12 – 23 months in shendi locality 2014.

Variables	Shendi	Almatam	Total	%
Immunised	**193**	**197**	**390**	**92.9**
Not Immunised	**17**	**13**	**30**	**7.1**
Total	**210**	**210**	**420**	**100.0**

N=420

Figure 3: MCV1record reported coverage 2011-2012-2013 for shendi & Almatam localities.

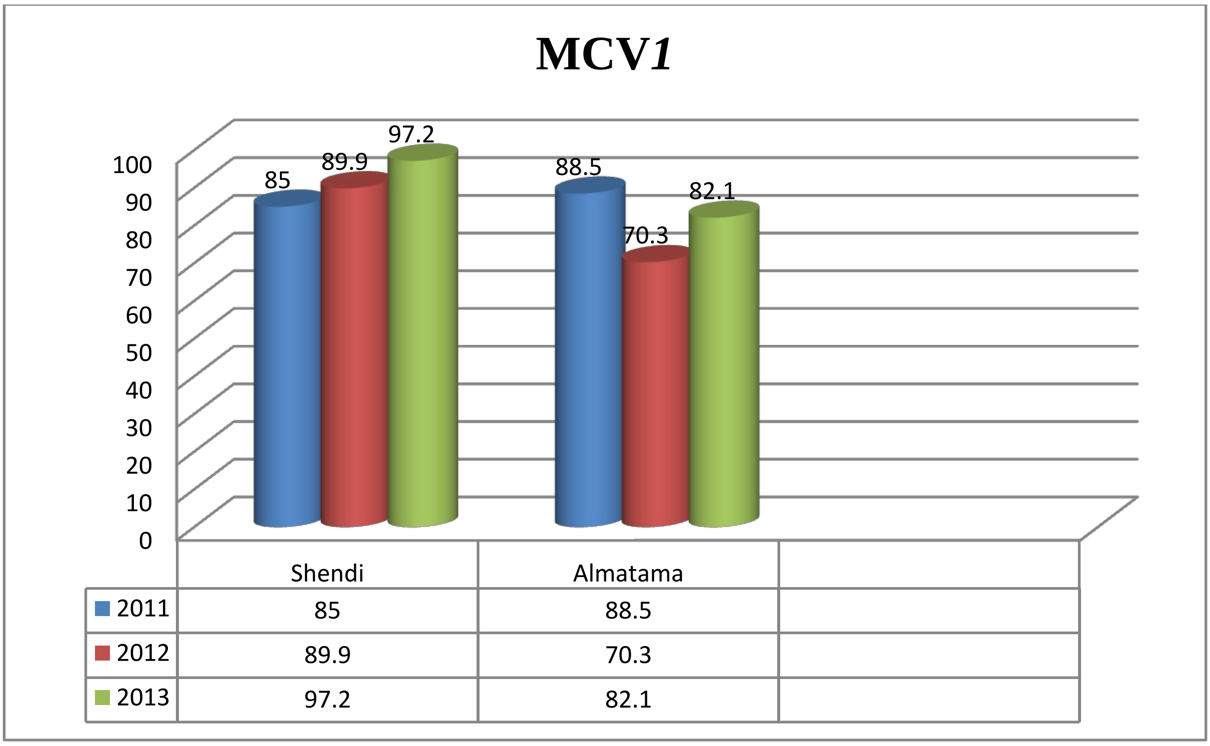


Figure (3) Shows that, MCV1 coverage in shendi locality is (85%) for year 2011, (89.9%) for year 2012 and (97.2%) for year 2013.Almatama is (88.5%) for year 2011, (70.3%) for year 2012and (82.1%) for 2013.

Figure 4: MCV2 record reported coverage for 2011-2012-2013 for shendi & Almatam localities.

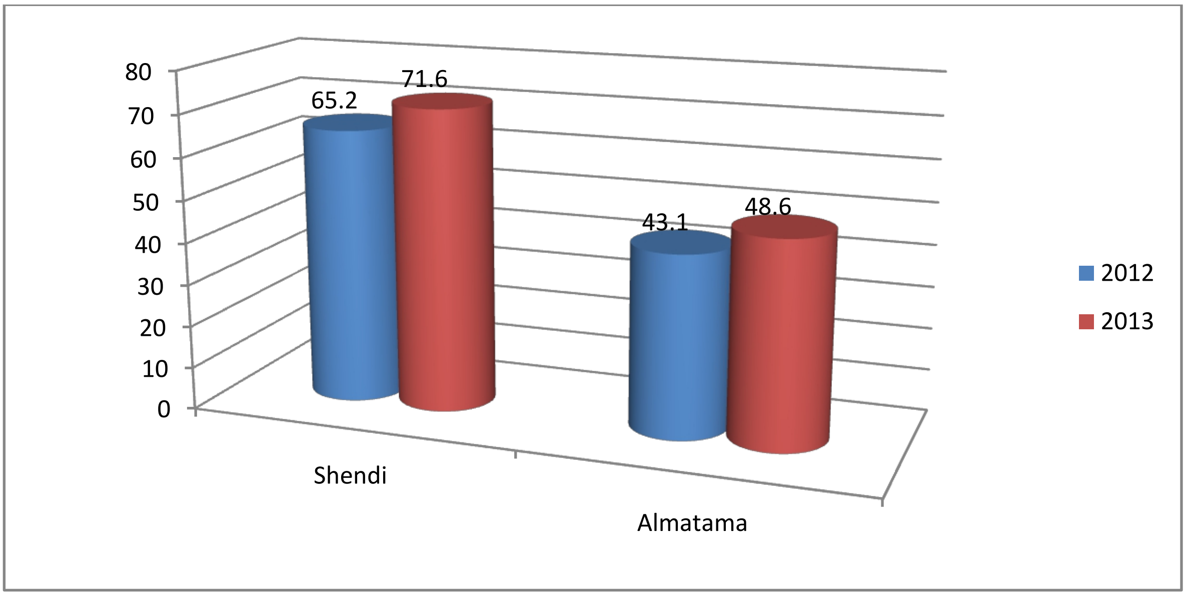


Figure (4) Shows that, MCV2 for shendi locality is greater in 2013 (71.6%) compared with (65.2%) in 2012 .in Almatama locality the MCV2 coverage is greater in 2013 (48.6%) compared with (43.1%) in 2012.

Table 7: The reasons of Measles vaccination failure for (MCV1) among the selected children in shendi locality 2014.

Variables	Frequency	%
Unaware Of Need To be Immunised	**5**	**29.4**
Unaware Of Need To Return	**4**	**23.5**
Place And Time Unknown	**4**	**23.5**
Immunisation Time Inconvenience	**2**	**11.8**
Vaccinator Absent	**2**	**11.8**
Total	**17**	**100**

N=17

Table 8: The reasons of Measles vaccination failure for (MCV1) among the selected children in Almatam locality 2014.

Variables	Frequency	%
Fear Of Side Reaction	**9**	**69.2**
Unaware Of Need To Return	**4**	**30.8**
Total	**13**	**100.0**

N=13

Figure 5: The reasons of Measles vaccine failure (MCV1) among the selected children in shendi & Almatam localities, 2014.

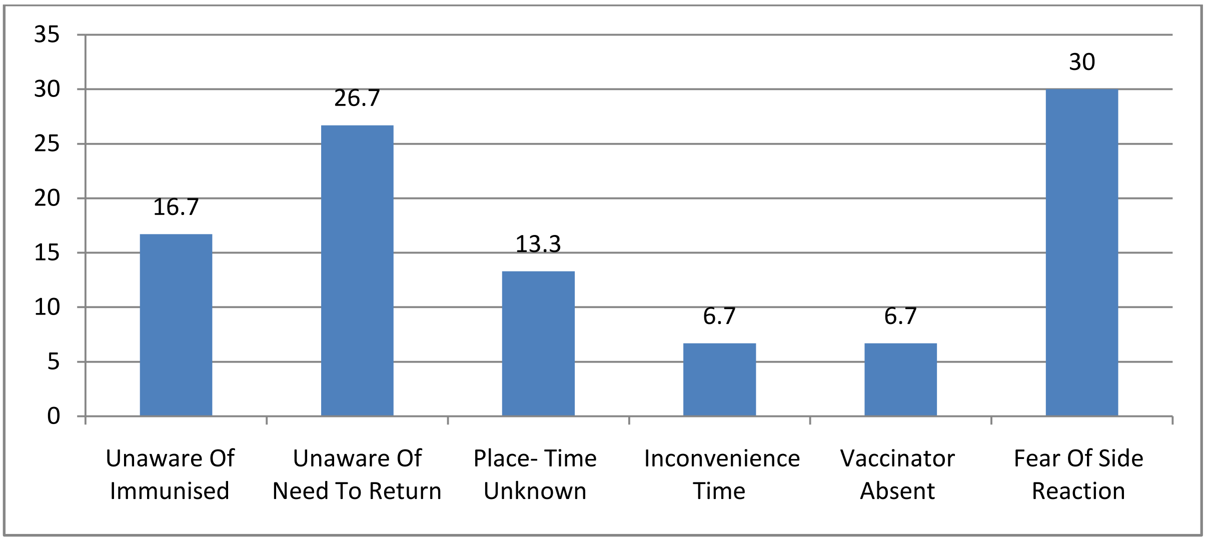


Figure (5) Shows the reasons behind vaccine failure .unaware of need to return is 26.7%, Fear of side effect is 30%, unaware of immunisation is 16.7%,place-time unknown is 13.3% , inconvenience time is 6.7% and vaccinator absent is 6,7%.

Table 9: the Measles second dose immunisation survey coverage among children Aged 18-24 months in shendi & Almatam localities 2014.

Variable	Shendi	Almatama	Total	%
Immunised	**178**	**181**	**359**	**85.5**
Not Immunised	**32**	**29**	**61**	**14.5**
Total	**210**	**210**	**420**	**100**

N=420

Figure 6: the Measles second dose immunisation survey coverage among children Aged 18-24 months' in shendi- Almatama localities2014.

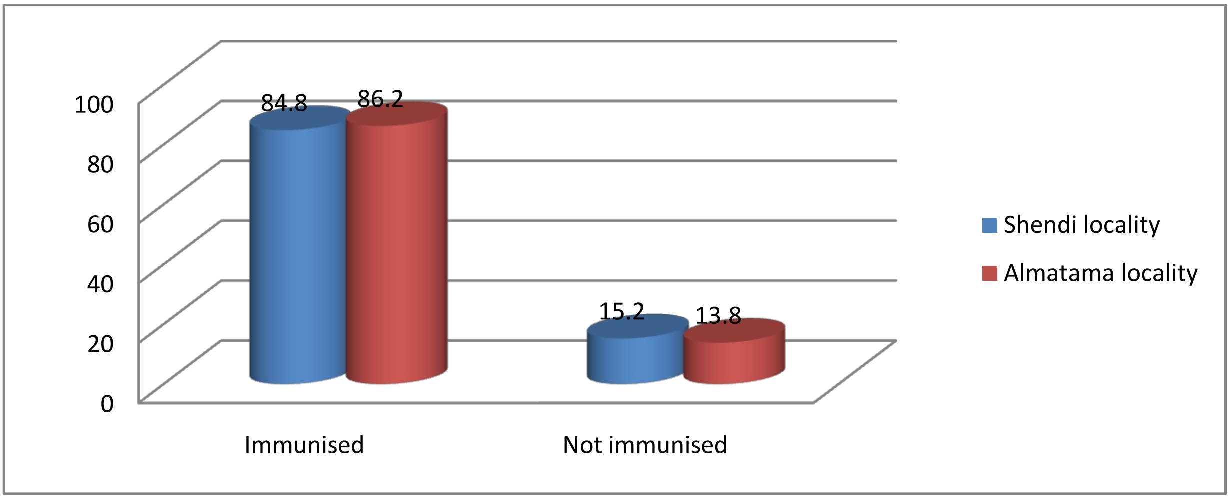


Figure (6) shows high immunisation coverage in Almatam 86.2%, shendi 84.8%.while 15.2% -13.8 % left-out in shendi and Almatama.

Table 10: The reasons behind the failure of taking second dose of measles vaccine among children aged 18-24 months in shendi locality 2014.

Variables	frequency	%
Unaware Of Need For Immunisation	10	31.3
Unaware Of Return	6	18.8
Place And Time Unknown	5	15.6
Fear Of Reaction	2	6.3
Time Inconvenient	3	9.4
Long Waiting Time	6	18.8
Total	32	100.0

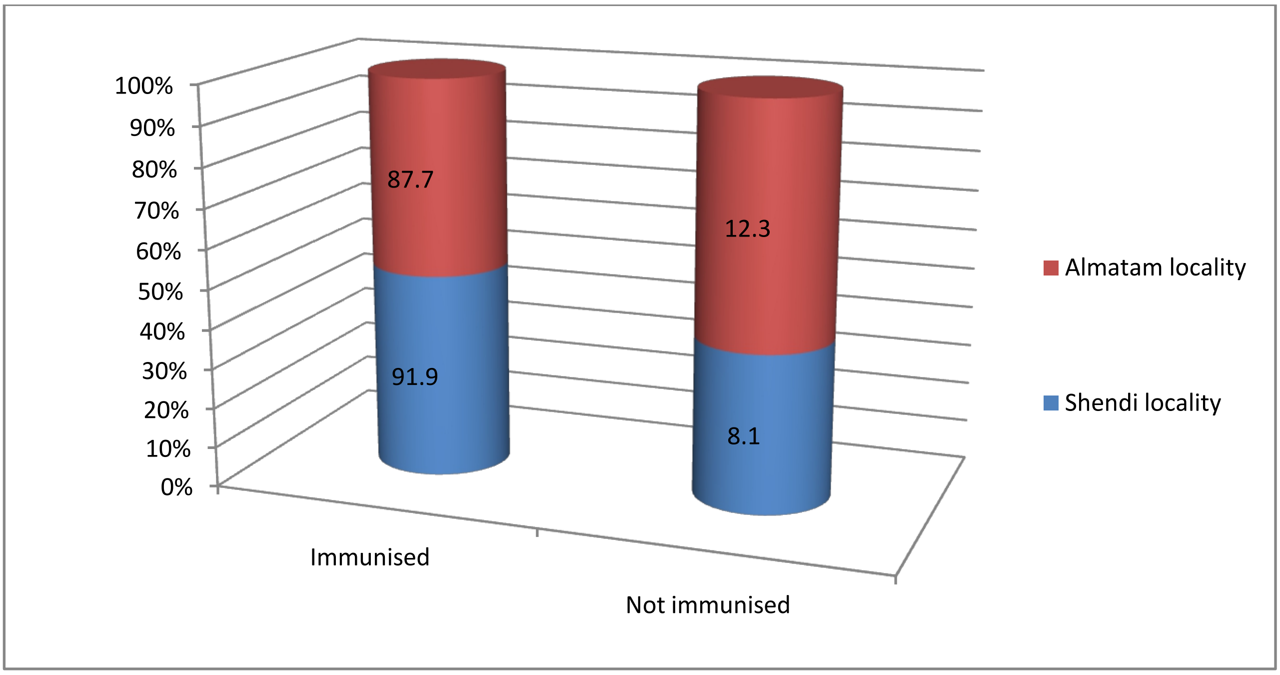
N=32

Table 11: The reasons behind the failure of taking second dose of measles vaccine among children aged 18-24 months in Almatama locality 2014.

Variables	Frequency	%
Unaware Of Return	19	65.5
Place And Time Unknown	2	6.9
Fear Of Reaction	8	27.6
Total	29	100

N=29

Figure 7: The survey of measles supplementary immunisation activities coverage among children Aged 9 months – 15 years in Shendi & Almatama locality 2014.



N=620

Figure (7) Shows measles supplementary coverage is only (89.6%) in shendi and Almatama localities, (87.7%) in Almatam locality and (91.9%) in shendi locality [CI 95%].

Table 12: The reasons behind Measles SIAs vaccination failure among children Aged 9 months – 15 years in Shendi locality 2014.

Variables	Frequency	%
Unaware Of Immunisation	12	50
Fear Of Reaction	6	25
Time Inconvenient	6	25
Total	24	100

N=24

Table 13: The reasons behind SIAs vaccination failure among children Aged 9- 15 years in Almatama locality 2014.

Variables	Frequency	%
Unaware Of Return	2	4.2
Unaware Of Immunisation	10	20.8
Place And Time Unknown	2	4.2
Fear Of Reaction	13	27.1
Time Inconvenient	19	39.6
Long Waiting Time	2	4.2
Total	48	100

N=48

Table 14: The sources of immunisation services distributed according to the EPI strategies in Shendi locality 2014.

Service Type	Frequency	%
Health Centre	156	74.3
Hospital	13	6.2
Outreach	28	13.3
Mobile Team	13	6.2
Total	210	100

N=210

Table 15: The sources of immunisation services distributed according to the EPI strategies in Shendi locality 2014.

Variable	Frequency	%
Health Centre	103	49.0
Hospital	85	40.5
Outreach	10	4.8
Mobile Team	12	5.7
Total	210	100

N=210

Figure 8: The sources of immunisation services distributed according to the EPI strategies in Shendi-Almatama localities 2014.

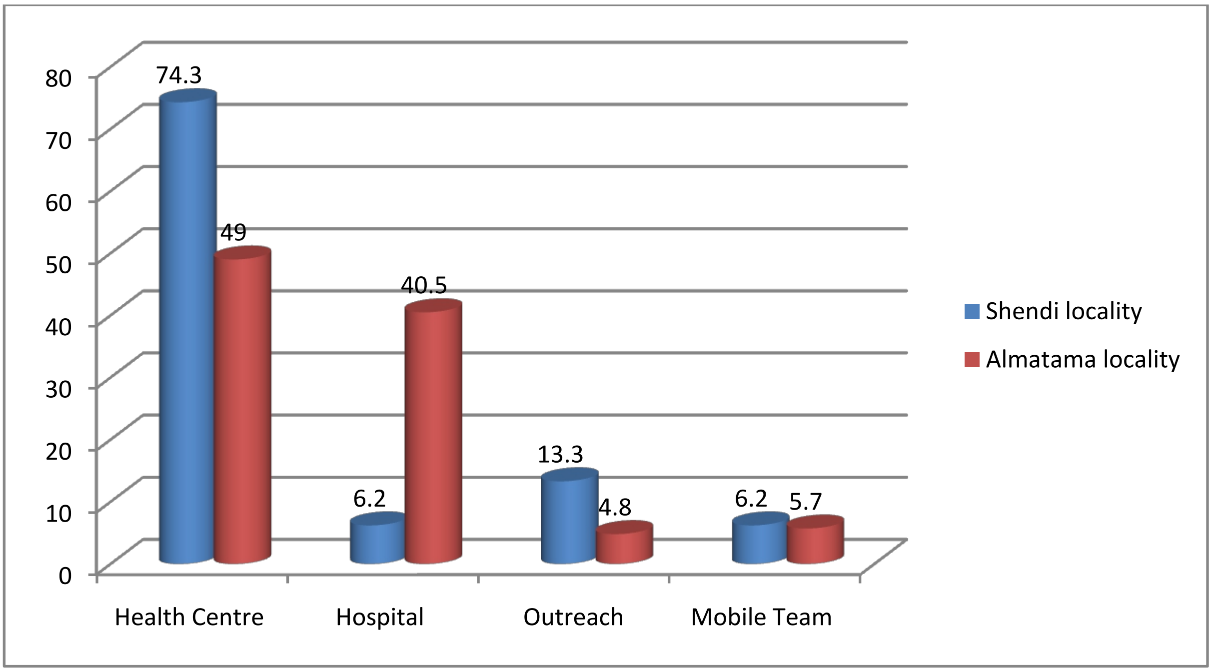


Figure (8) Shows that most of population are seeking immunisation services from health care (74.3%)in shendi ,(49%)are in Almatama .less number of population are immunise in outreach (13.3%)- (4.8%) , and mobile team is (6.2%)- (5.7%) in shendi and Almatama .

Table 16: Awareness of mother's about Measles disease and complication in shendi locality 2014.

Variables	frequency	%
Aware	**184**	**87.6**
Not Aware	**26**	**12.4**
Total	**210**	**100**

N=210

Table 17: Awareness of mother's about Measles disease and complication in shendi Almatama locality 2014.

Variables	frequency	%
Aware	**148**	**70.5**
Not Aware	**62**	**29.5**
Total	**210**	**100**

N=210

Figure 9: The mother's awareness about Measles disease and complication in shendi & Almatam locality 2014.

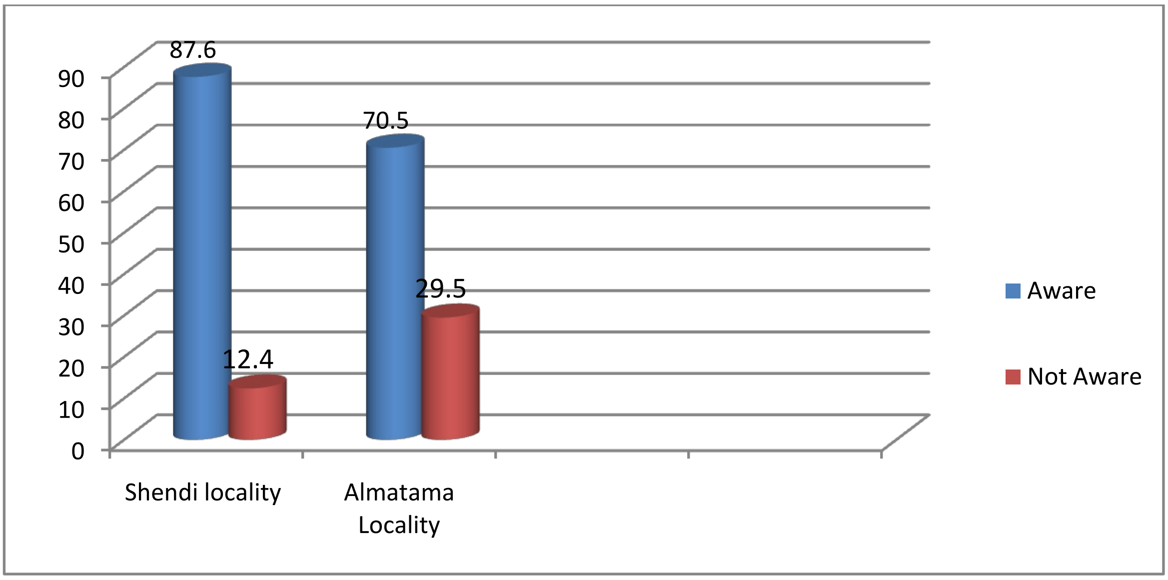


Figure (9) Shows that most of population are aware about measles disease and complications (79. %). Shendi locality shows high awareness (87.6%) compared with (70.5%) in Almatama locality.

Table 18: The sources of information about Measles among study population in Shendi locality 2014.

Variable	frequency	%
health centre	42	22.8
TV	74	40.2
Radio	13	7.1
others	55	29.9
total	184	100.0

N=184

Table 19: The sources of information about Measles among study population in Almatama locality 2014.

variables	frequency	%
health centre	55	37.2
TV	45	30.4
Radio	27	18.2
others	21	14.2
total	148	100.0

N=148

Figure 10: Distribution of the information's sources about Measles among study population in Shendi & Almatama localities 2014.

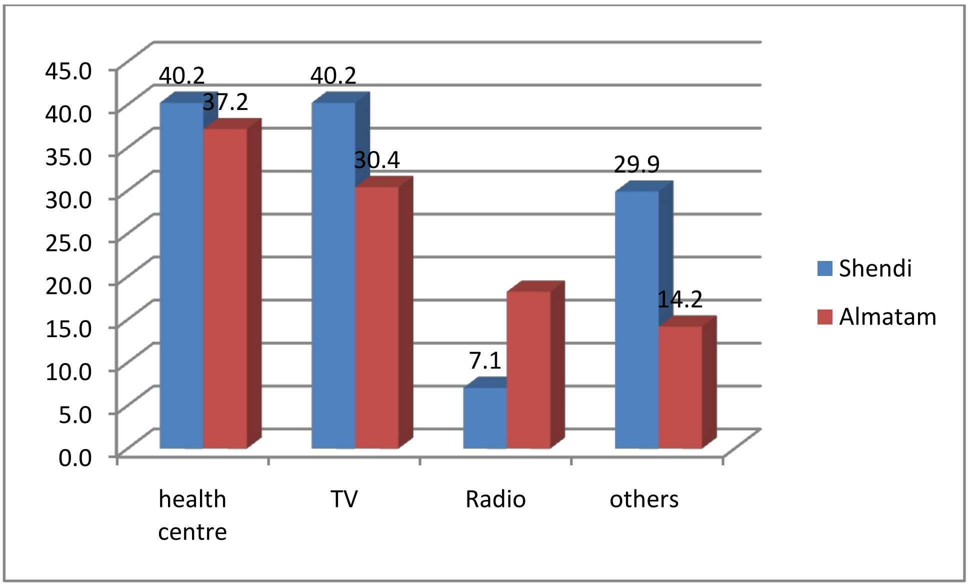


Figure (10) Shows that most of population are have information about measles from TV (35.8), health centre is (29.2 %) and less effective methods is radio (12%) and others is (22%).

Table 20: The relationship between mother`s educational level and children vaccination status among selected children in Shendi & Almatam localities 2012.

variables	vaccinated	not vaccinated	total
literacy	29	18	47
primary	225	50	275
secondary	283	15	298
Graduated and post	207	13	220
total	744	96	840

P. value < 0.05 significant N=840

Figure 11: The relationship between mother`s educational level and children vaccination status among selected children in Shendi & Almatam localities 2014.

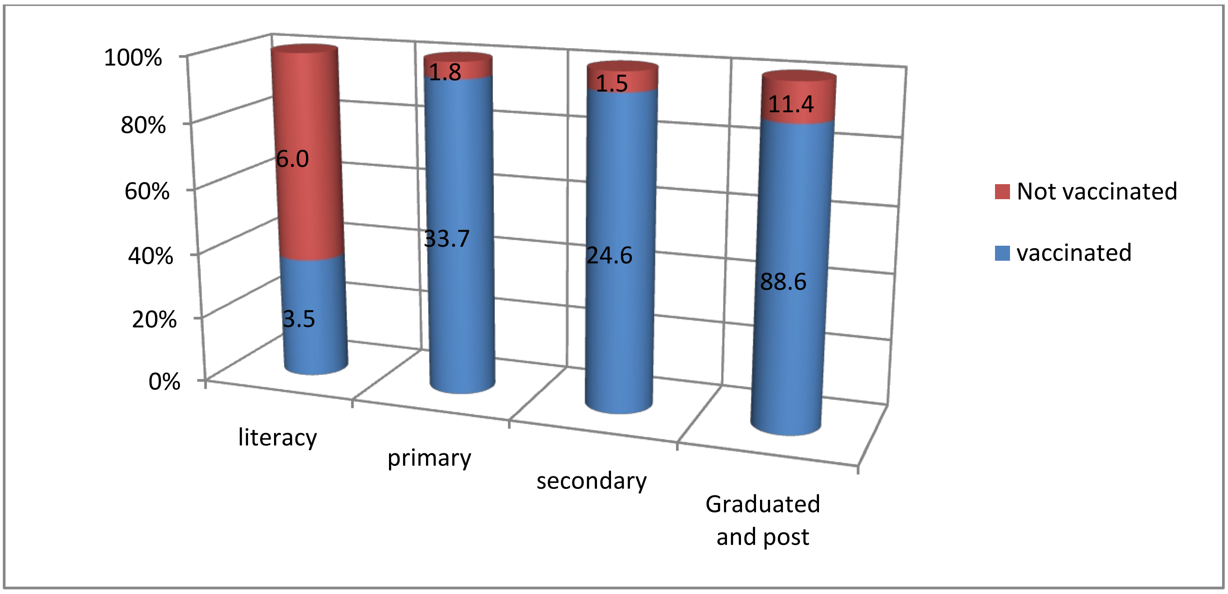
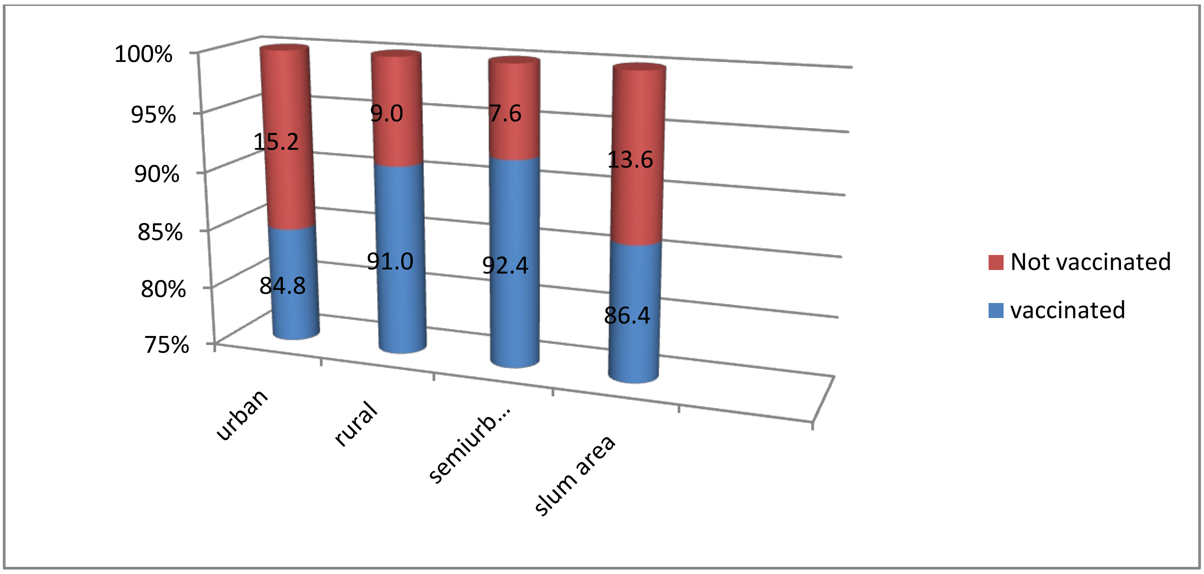


Figure (11) Shows that, most of illiteracy mothers were not vaccinate their children (6%)compared with (3.5%) were vaccinate their children .it is also shows high coverage among mothers having primary education (33.7%) and graduated mothers (88.6%) .P.value indicates significant relationship.

Figure 12: The relationship between the mother's resident area and children vaccination status in Shendi & Almatama localities 2014.



P.value ≤ 0.05

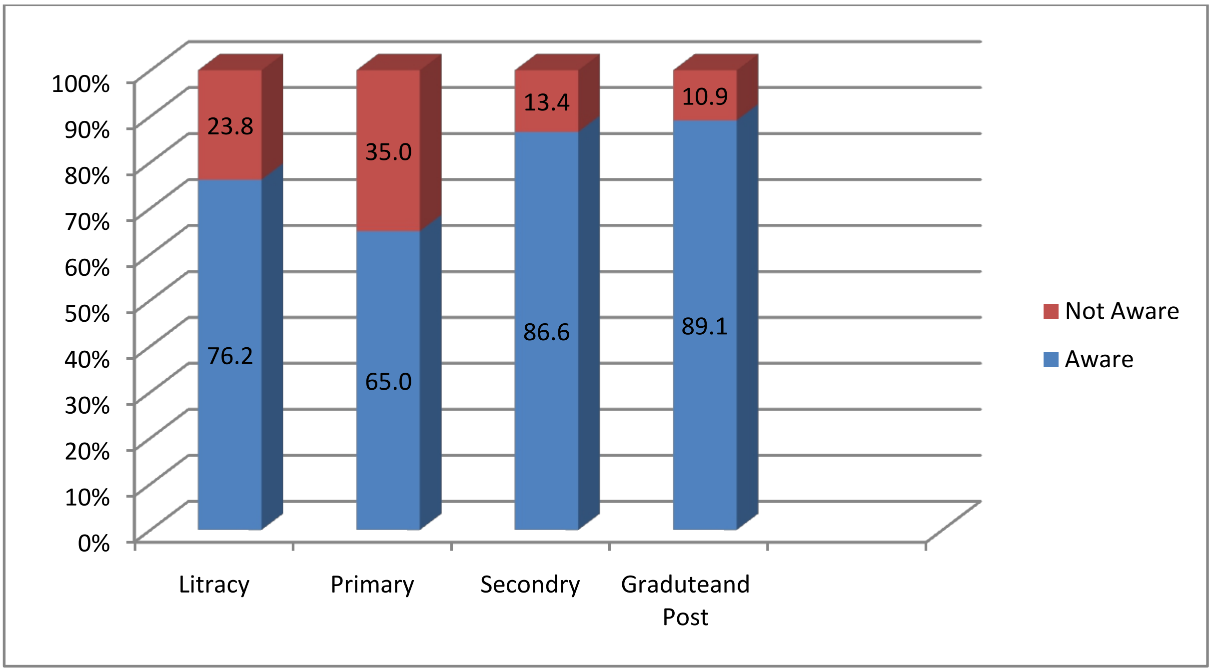
Figure (12) A cross tabulation between children vaccination status and mother`s resident area, A high coverage appear in rural area (91.0%) and semi-urban area (92.4%) and less coverage appear in slum area (86.4%).*P.value* indicates significant relationship.

Table 21: The relationship between mother`s educational level and their awareness about measles complication in Shendi & Almatama localities 2014.

Variables	Yes	No	total
Illiteracy	16	5	21
Primary	91	49	140
Secondary	129	20	149
Graduate and Post	98	12	110
Total	334	86	420

P.value < 0.05 significant N=420

Figure 13: The relationship between the educational level and awareness about measles complication in Shendi –Almatama localities 2014.



P.value >0.05 Not significant

Figure (13) shows that, high percentage of primary education not aware (35%), (23%) of the illiteracy not aware and only (10%) in graduate and postgraduate not aware, *P.value* indicated that, no significant relationship.

Surveillance indicators

Table 22: Routine and surveillance coverage information of Almatama Locality.

Item	2011	2012	2013
No. of Health Facilities	10	10	10
No. of surveillance site	3	3	3
MCV1 coverage	4157	3303	3857
MCV2 routine immunisation coverage	-	2025	2284
Measles drop- out rate	5	15	9
SIAs coverage	No campaign	No campaign	101%
No of clinicians	3	3	3
No of vaccinators	27	27	27
Measles focal persons	3	3	3

Source [60].

Table 23: Routine and surveillance coverage information of Shendi Locality.

Item	2011	2012	2013
No .of health facilities	46	46	52
No. of surveillance site	5	5	7
MCV1 coverage	8343	8826	9540
MCV2 routine immunisation coverage	-	6402	7031
Measles drop- out rate	6%	9%	7%
SIAs coverage	No campaign	No campaign	98.7%
No of clinicians	46	46	52
No of vaccinators	34	35	38
Measles focal persons	5	5	7

Source [61].

Table 24: Measles surveillance indicators in shendi locality.

	Indicator(80% WHO standards)	2011	2012	2013
1.	% of sites reporting weekly	100	100	100
2.	% of cases notified within <48 hours of onset of rash	100	98	100
3.	% of cases investigated within <48 hours of notification	100	100	100
4.	% of cases with adequate specimen (blood, urine,…)	100	100	100
5.	% of cases with laboratory results within 7 days	0	0	0

Source [61].

Table 25: Measles surveillance indicators in Almatama locality.

	Indicator(80% WHO standards)	2011	2012	2013
1.	% of sites reporting weekly	100	100	100
2.	% of cases notified within <48 hours of onset of rash	100	98	100
3.	% of cases investigated within <48 hours of notification	100	100	100
4.	% of cases with adequate specimen (blood, urine,…)	100	100	100
5.	% of cases with laboratory results within 7 days	0	0	0

Source [60].

Clinicians Awareness

Table 26: Gender distribution of the clinician whom working in shendi & Almatam localities hospitals 2014.

Gender	Shendi	Almatama	%
Male	8	2	37.0
Female	17	0	63.0
Total	25	2	100.0

N=27

Table 27: Job status of the clinician whom working in shendi & Almatam hospitals 2014.

Job status	Shendi	Almatam	%
House officer	15	1	59.3
Medical Officer	4	1	18.5
Specialist	6	0	22.2
Total	25	2	96.3

N=27

Figure 14: Job status of the clinician whom working in shendi & Almatam hospitals 2014.

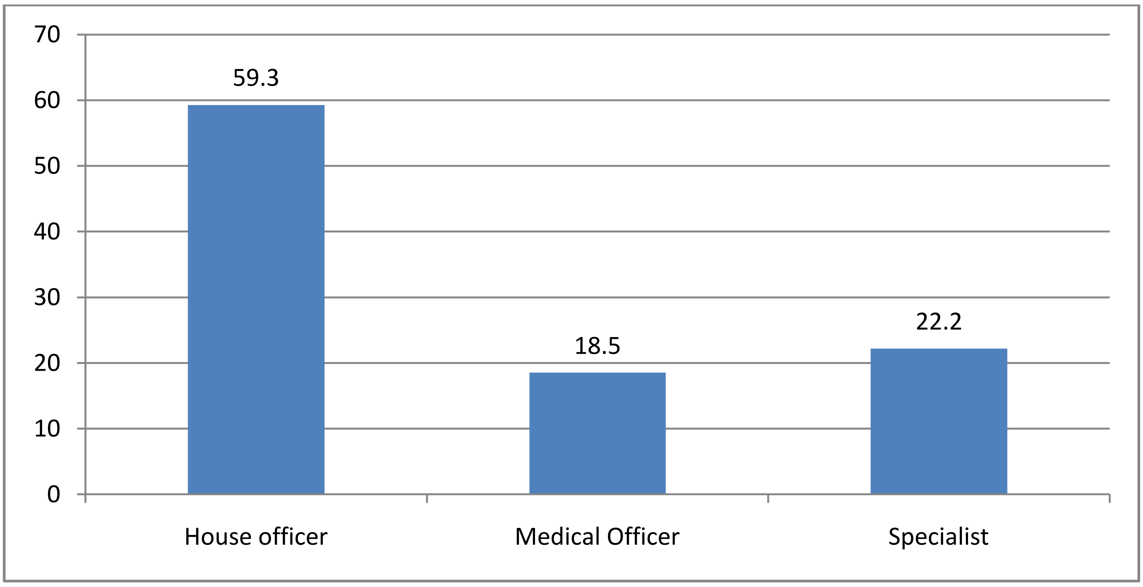


Figure (14) Shows that the job status of clinicians is majority of them are House officer (59.3%), only (22.2 %) is specialist and (18%) are medical officer.

Table 28: The years of experience among clinicians whom working in shendi & Almatama localities Hospitals 2014.

Years of experience	Shendi	Almatama	%
1-3 years	11	2	48.1
4-6 years	11	0	40.7
> 6 years	3	0	11.1
Total	25	2	100.0

N=27

Figure 15: Clinicians training about Measles surveillance in shendi & Almatama hospitals 2014.

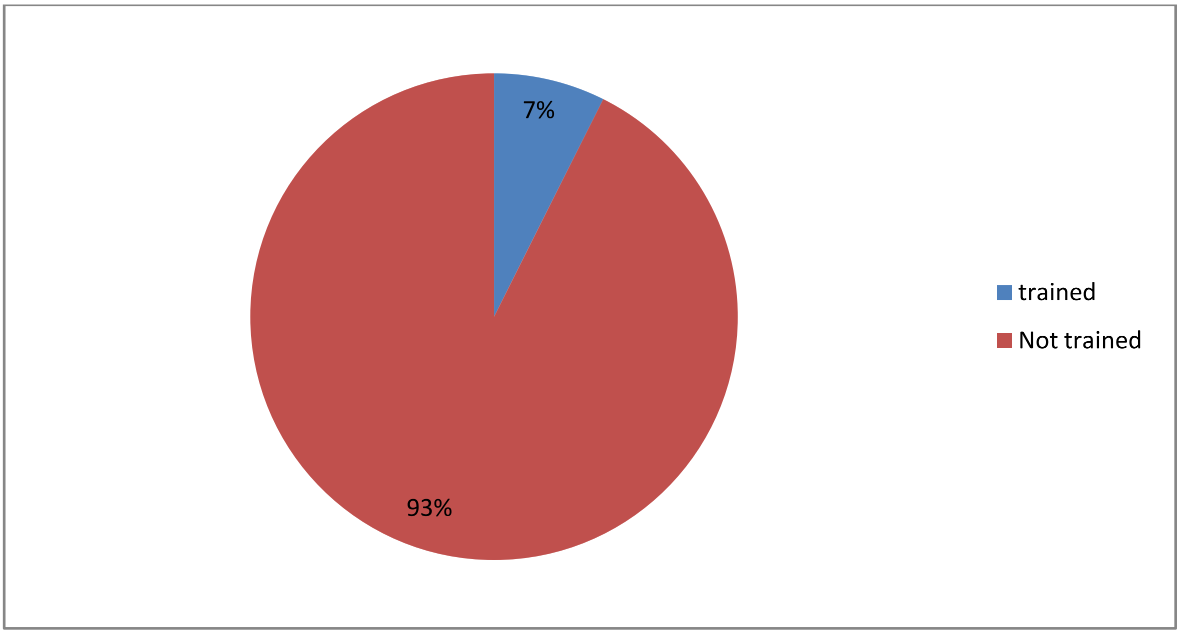


Figure (15) shows the training status regarding measles surveillance system in shendi and Almatam locality, only 7% of the clinicians had training before and most of them are untrained 93%.

Table 29: Clinicians training about Measles surveillance in shendi & Almatama hospitals 2014.

Training status	Shendi	Almatama	%
Trained	1	1	7.4
Not trained	24	1	92.6
Total	25	2	100.0

N=27

Table 30: Clinician's awareness about Measles case Definition in shendi & Almatama hospitals 2014.

Awareness status	Shendi	Almatama	%
Aware	3	1	14.9
Not aware	22	1	85.1
Total	25	2	100.0

N=27

Table 31: Clinician`s awareness regarding Measles national reporting system in shendi & Almatama Hospitals 2014.

Awareness status	Shendi	Almatama	%
Aware	2	0	7.4
Not aware	23	2	92.6
Total	25	2	100.0

N=27

Table 32: Clinicians whom seen and report a Measles cases in shendi & Almatama Hospitals 2014.

Report status	Shendi	Almatama	%
Report	22	2	88.9
No report	3	0	11.1
Total	25	2	100.0

N=27

Table 33: Clinicians received feedback from EPI after reporting cases in shendi & Almatam hospitals.

Variables	Shendi	Almatama	%
Received	1	2	11.1
Not received	24	0	88.9
Total	27	2	100.0

N=27

Table 34: Availability of Surveillance materials in clinician's offices in shendi & Almatam hospitals.

Variables	Shendi	Almatama	%
Available	6	2	29.6
Not available	19	0	70.4
Total	25	2	100.0

N=27

Qualitative results from interview with EPI operation officers in Shendi & Almatama localities:

Surveillance data availability and use:

- Administrative unit level still under initiating in EPI system ,therefore the sub detailed data in certain level were not available .
- There was no registration logbook for Measles default tracing in locality level.
- Surveillance network plan was available and displayed and there were additional heath facilities planned for review and check for existence of cases.
- Regular surveillance reports were available and No evidence to use this data in decision making actions (Graphics display, supplementary immunisation activities response, routine immunisation and training).

Standard operation procedures (surveillance materials):

- All measles surveillance materials were available including surveillance guide line, SOPs, case definitions, line listing and case investigation.
- No outbreaks reports available in locality level and there were any minimum data management and analysis for reviewing.

Surveillance Training and supervision:

- No continuing training plan for the staff that involved in measles surveillance in both localities and no any feedback system from the upper level to the clinicians in the hospitals and health facilities.
- Samples from suspected case were routinely collected in reporting site by focal persons.
- Very good supplying system of sterile equipment supplies for blood collection and clinical specimen.

- There is no evidence of sending lab result periodically to the health facilities which reported suspected cases.

Qualitative result from the surveillance health facilities in shendi and Almatam localities.

- Focal persons were not available in shendi teaching hospital at the time of interviewing and no backup person in case of unavailability.
- All focal persons in surveillance facilities knows the standard measles definition and reporting of suspected measles cases to the locality fallowing the standard operative procedures.
- Focal persons have a very good knowledge with regard to the purpose of measles active search in surveillance facilities.
- No any link conducted with the local community to enhance surveillance among community and no document available for future planning.
- Measles suspected cases Laboratory results were usually received after more than 3 weeks in all health facilities in shendi and Almatama localities.
- No supportive supervision conducted in the last month of interview for the health facilities and there is no supervision book for observation and action point available.
- Incomplete files documentation observed in shendi locality at surveillance facilities, files were checked including measles line listing, reported case folders, notification reports and community education materials.

Chapter (5)

Discussions

Chapter (5)

Discussion

5.1 Immunisation coverage:

In the present study and according to the 30 cluster survey conducted in the study area, the measles's first dose coverage was (93.8% - 91.9%) with an Average of (92.8%) [CI 95%] in Shendi and Almatama localities respondents. This coverage represents the routine coverage for children below one year. The measles's second dose coverage for children aged 18-24 months was (84.8% - 86.2%) [CI 95%] in Shendi-Almatama localities .Additionally the reported coverage was (89.7%) from EPI 2013 report [(61)]. However, these averages don't meet the WHO standard criteria to eliminate measles disease; there is still a large gap to achieve (95%) coverage. The left-out rate of MCV1 was considered as the key reason for measles prevalence in the younger age-group of (8 to 12 months). These results indicate the need to accelerate the improvement of the age-appropriate immunization rates for MCV1and MCV2. (Providing the first dose of measles vaccine to successive cohorts of infants 95% and Ensuring that all children have a second opportunity for measles vaccination95%) [(10)].

The post measles SIAs survey overage were (91.9% - 87.7 %) Average (89.8%) [CI 95%] in shendi & Almatama localities comparing with (101% -98.7%) Average (99.8%) as administrative coverage , and this is reflects a poor quality of SIAs performance considering the importance of achieving high SIAs performance to increase the cohort immunity by decreasing the numbers of susceptible children with providing the second measles dose opportunity as well as the second doses of routine immunisation (A second dose of measles vaccine, available through good quality supplemental immunisation that reduces the proportion of susceptibility in a given population quite rapidly, this prevents measles outbreaks in the context of high routine immunisation coverage, which further can help to eliminate indigenous measles transmission) [(62)].

Although the reported coverage is high, the study also showed poor immunisation cards record keeping available for performance among respondents (15.2% - 20.5%) [Average 17.9%] in shendi & Almatama localities .The reasons behind unavailability were : lose through carelessness by the holders (lost) (52%) and (12%) had never been received an immunisation cards for their child , consequently this decreases the opportunity of tracking immunisation status among the target children in case of outbreak, immunisation survey for elimination purpose or even travelling .The health workers in immunisation site need to focus on the importance of keeping immunisation cards in safe places (An immunization card keeps track of the immunizations**.** It is very important the cards should be kept in a safe place. Immunization records may be required for school, work, or travel. They may be needed if an outbreak occurs to provide proof of protection) [(63)]and this is in agreement with the study done in Yemen and it showed poor performance regarding availability of immunisation cards [(64)].

Concerning the reasons behind vaccine intake ,the present study showed that respondents reported the primary reasons for children not being ever vaccinated against measles to "long waiting time", "unaware of the need to immunisation", "unaware of return for next dose", and ``immunization post too far``(Table 24) .This is agreement with previous study conducted in Eretria 2012 [(65)]. These results indicate the poor utilisation of immunisation health services increasing the possibility to elevate the numbers of susceptible children. Additionally the factors of unvaccinated children during the SIAs were ''unaware of immunisation '', ''fear of reaction '' and ''time of immunisation in convenience'', (Table 27) and this is in line with studies conducted in developing countries including Sudan [(66) (67)]. A previous study conducted in Kenya found that, in systems where parents have to expend time and energy to vaccinate their children, utilizing outreach can reduce prevailing gender and socioeconomic differences in vaccine received [66].

Educated mothers were more likely to have their children immunised than mothers who had no education. Mothers with secondary and higher education had a great chance for full immunisation than more than half of the illiterate respondents who had unvaccinated children (Table 35) and this is in line with study carried out in southeast Asian [68],.and study conducted in Tanzania which found that (a child whose mother had completed primary or had not attended school was three times more likely to have a low uptake than a child whose caretaker had completed secondary school) [69].

Substantial differences in vaccination status rates were found for children in urban and rural areas. Rural areas had the highest coverage rates compared with urban and slum areas. This is probably partly due to the general distribution of immunisation services strategy because they depend on mobile team in rural area and that may boost access opportunity and diminish dropout rate, this result disagrees with previous study done in Sudan and found that (Mothers of children from urban areas reported correct vaccination more than mothers of children in rural areas) [67] and also dissimilar with another study accomplish in Uganda and found that (58% of children in urban areas were fully immunized compared to 53% of children in rural areas.) [70].

The study found that high proportion of participants were aware about measles disease and its complication (Figure 10) and this reflects positive way to enhance measles elimination in term of involving the community to increase the immunisation coverage and reducing dropout rate ,the most sources of information were reported on TV and by health workers (Figure 9), this is in agreement with study conducted in Nepal and found that (Forty percent of the respondents tagged health workers as their main source of information, and more than half (54.2%) received some information form health workers on immunisation) [71] .Also our study found that a great number miss this opportunity noted in Elmak Nimir University hospital due to unavailability of immunisation services in the hospital while this facility is receiving and admitting huge numbers of children daily.

5.2 Surveillance indicators

Our results confirmed that, the surveillance indicators (>2 reported suspected measles cases Per 100 000 population), (at least 80% of suspected cases adequately investigated within 48 hours),**(**Greater than 80% of cases had adequate blood samples collected**)** and (80% of sites reporting weekly) as quality of indicator has been met and achieved in both localities and this indicates strong level of staff commitment in the last three years(Table40,Table41) . Elevating cut-off levels of indicators is highly recommended to achieve high performance; this is in line with study done in Australia and came out with similar result [(72)] . The indicator (80% of cases with laboratory results within 7days) still zero percent and it is not achieved, To ensure quality of results and timeliness of reporting at least 80% of results sent in time to assist in diagnosis and identification of outbreaks trend as well as improving the quality prevention and control .Immediate feedback from laboratory to EPI office it is highly recommended in confirmed cases. We agree with (quality surveillance criteria should be guided by elimination criteria, not the other way around) [(73)]. Very high reporting system sensitivity noted in both localities and they were adding numbers of private clinics in surveillance net work, conversely, very poor community link in surveillance activities in both localities and it is considered a great miss opportunity to enhance surveillance system by increasing the community awareness to participate in case notification and detection, this is doesn’t agree with study conducted in India that found out that (active search for suspected measles cases in health facilities and in the community during outbreaks were critical elements in the success of the surveillance system) [(74)].

This study revealed that numbers of outbreak reported in rural area in shendi and Almatama localities during last three years, however ,its expected negative consequences because of the huge gaps in immunisation coverage specifically MCV2 (failure to vaccinate, vaccine failure, accumulation of susceptible persons) [10], Outbreak reports show that data was not available in locality level as well as absence of any evidence of analysing or displaying data, This results highlight the difficulty of utilising surveillance data to control the outbreaks .(Outbreak prevention requires not only one-dose coverage to be increased, but also coverage with a second dose provided by a routine vaccination system or by supplemental activities) [75]. (The sero-conversion rate of measles vaccine at 9 month of age is 85%, accordingly, even in regions where routine immunization coverage is high, some children from each birth cohort remain susceptible to measles) [76].

Our study revealed that all focal persons (12 focal persons) who serve in surveillance site have a high knowledge about (standard measles definition and reporting of suspected measles cases) and this might indicates their long experience in surveillance system, with job stability. We also noted that they all have a well knowledge about the purpose of surveillance and active search, .this agrees with study conducted in Ombada locality and revealed high staff knowledge regarding surveillance system [77]. Measles reported site were not receiving the lab results in regular base (usually not before 3 weeks) this reflected poor surveillance performance indicator and can lead to elevate the numbers of cases among susceptible population.

The documentation reviewing revealed low standard level in surveillance site ,see also case reporting file, case line listing, case definition , monthly reporting site, and community education material were not completed .(documentations of measles elimination activities playing an importance in roles of verifying elimination of Measles endogenous virus [78]).

5.3 Clinicians Awareness

The clinician's awareness is considered as a cornerstone in measles elimination process .Our study found a great lack in measles surveillance training among clinicians working in shendi & Almatam localities, there only (7.4%) had training during year 2013 (Table 45),only(14.95) were aware about measles standard case definition(Table 46) most of them define a measles case as (atypical skin rash in person with positive exposure to a known case),(Fever, running nose ,red eyes and general macopapualr skin rash)and (viral infection cause skin rash pneumonia and eyes infection) and it doesn't match WHO standard case definition (any child or adult with fever and one of the flowing symptoms cough, coryza and conjunctivitis or any persons suspected by clinician) . In Addition about (7.4%) showed good knowledge concerning measles reporting system (Table 47).

Chapter (6)

• Conclusion

• Recommendations

5.1 Conclusions

- The measles first dose coverage (MCV1) was (92.8%) and it doesn’t match the WHO measles standard criteria for measles elimination.
- The measles second dose coverage (MCV2) was (83.5%) and it doesn’t match WHO measles standard criteria for measles elimination.
- The last supplementary immunisation coverage survey was (89.8%) as a total of both localities and it doesn’t match the WHO measles standard elimination criteria.
- Immunisation card availability was (17.9%) in both localities and (52.0%) were lost.
- The top reasons behind improper vaccine uptake were ``long waiting time``, ``unaware of need to immunise``, ``unaware of return to second dose `` and vaccination post is too far from human dwellings``.
- Educated mothers were more likely to have their children immunised than mother who had low or non education
- A high proportion of participants are aware on the subject of measles and its complications (79%) and the highest source of information reported was from television (35.8%).
- Very high performance matching WHO measles elimination criteria was reported in terms of ``number of measles suspected cases ``, ``case investigation within 48 hours `` ``adequate blood sample collection`` and `` rate of weekly reporting site ``
- The indicators of receiving laboratory results within 7 days are still irrelevant or zero and not achieved.
- Outbreak reports data were not available in localities level as well as absent of any evidence of analysing or displaying data.
- There was no community linkage with measles surveillance system to increase the sensitivity of community case notification and detection.

- All focal persons in surveillance sites were aware about measles case definitions and reporting systems.
- Low level of documentation procedure was reported in surveillance sites and it is present in incomplete bits and absence of important documents included case reporting files, case line listing, case definitions posters, monthly reporting files and community education materials.
- Only (7.4%) of clinicians had previous training on measles surveillance system in the both localities.
- Only (14.9%) of the clinicians who are working in hospitals were aware about the standard measles case definition and surveillance reporting system.

5.2. Recommendation

National immunisation program,

- should conduct a periodic immunisation surveys especially in high risk groups To obtain high level for first dose of measles coverage vaccine for children between (9month -18 month) on the way to elevate the immunity level and decrease the numbers of susceptibility among targeting groups, National immunisation program.
- should focus on improving the quality of supportive supervision, teams selection and performance and data quality management's insure high supplementary immunisation activities coverage with high performance quality in support of accelerating the community immunisation level and preventing outbreaks, National immunisation program and state program

State Immunisation Program,

- Should conduct Regular and systemic training process to enhance the clinician's awareness in focus on House officers groups To elevate clinicians awareness a achieve measles surveillance sustainability in shendi and Almatama localities,.
- operation officers in shendi and Almatam localities need to strengths the community link approach through educate community to support surveillance and immunisation activates to insure high level of community engagement in measles elimination activities in both localities,

Shendi & Almatama local authorities,

- Should review and strength the surveillance network plan regularly to create sensitive measles surveillance system enough to identify measles circulating virus in the community, shendi local authority should be scale up the training of surveillance personnel and provide adequate surveillance supplies in order to enhance the outbreaks investigation and response in localities and districts levels.

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Annexes

Annexe (1)

Assessment of Measles Elimination's Criteria in shendi & Almatama localities

In River Nile State, Sudan 2012-2015

District & locality Level questionnaire

Date: / / 20 State................................
locality..................... District.............................

A- Demographic and Population Data:

Item	Number	Source/ year
Total population		
Under 1		
1-4 years of age		
5 – 9 years		
10 – 14 years		
15 and more		

B- Routine and surveillance coverage information :

Item	2011	2012	2013
No of HFs			
No of surveillance site			
MCV1 coverage			
MCV2 RI coverage			
Measles drop- out rate			
SIAs coverage			
No of clinicians			
No of vaccinators			
Measles focal persons			

1- Is the registration logbook for vaccination and default tracing available and completed?

Yes ☐ No ☐

2- Is there displayed of monitoring chart for vaccination coverage?

Yes ☐ No☐

3- Is the surveillance net-work plane is available and displayed:

Available ☐ Displayed ☐

4- Is there other health facilities not participating in surveillance are planned for review/ check for existence of cases?

Yes ☐ No☐

C- <u>Surveillance Data, Availability and Use</u>

1- Does the District receive reports regularly according to the agreed schedule (i.e. monthly or quarterly) from the reporting sites?

Yes ☐ No ☐ [If yes, ask to review data]

2- Have data from the surveillance been used by the District for decision making/ action?

Yes ☐ No ☐

3- If yes, how?

Graphic outbreaks display☐ SIAs response ☐ strengthening RI ☐ training ☐

4- Do the district /locality conduct active surveillance based on net-work plane?

Yes ☐ No ☐

5- If yes, review the active visit registration book

Regular visit ☐ Irregular visit ☐

6- Is there enough number of measles focal persons in the district /locality level?

Yes ☐ No ☐

7- Is there an alternative focal person for backup in all health facilities?

Yes ☐ No ☐

D- <u>Standard Operating Procedures: Obtain copies and review after interview</u>

1- Are there measles surveillance guidelines, SOPs, manuals or guidelines at this site?

Yes ☐ No ☐

2- If yes, ask to observe the document(s) and obtain a copy.

a- Observed? Yes ☐ No ☐

b- Copy obtained? Yes ☐ No ☐

3- If the above document/s is/are available, indicate which of the surveillance aspects below are:

	Availability?	Consistent with WHO criteria?
a- Case definitions	Yes ☐ No ☐	Yes ☐ No ☐
b- Line listing	Yes ☐ No ☐	Yes ☐ No ☐
c- Case investigation form	Yes ☐ No ☐	Yes ☐ No ☐

d- Measles surveillance guidelines Yes ☐ No ☐ Yes ☐ No ☐

e- Specimen collection and transport Yes ☐ No ☐ Yes ☐ No ☐

f- Minimum Data management & analysis Yes ☐ No ☐ Yes ☐ No ☐

g- Outbreak reports Yes ☐ No ☐ Yes ☐ No ☐

E- Training, Supervision, and Use of Data

1- Is there a plan for continuing education/training for staff involved in measles surveillance?

Yes ☐ No ☐ Unknown ☐

2- Is there a plan for continuing education/training for staff involved in measles surveillance?

Yes (describe below) ☐ No ☐ Unknown ☐

3- Do you receive feedback from the state level on data you have reported, e.g. about data quality, information on duplicated records, etc.?

Yes ☐ No ☐ Unknown ☐

4- Are visual aids displayed for the staff to follow a protocol?

Yes ☐ No ☐

F- Specimen Collection and Transport

1- Are specimens routinely collected from all suspected measles cases by reporting site staff or district?

Yes No

2- Are supplies of essential materials (i.e. sterile equipment supplies for blood collection, other clinical specimen etc?) (*Observe stock on hand and comment)*

Available Yes ☐ No ☐

Enough yes ☐ No☐

3- Are the lab results sent to the reporting site/ clinician in a timely manner?

Yes ☐ No ☐

G- Feed forward/ Feedback back

1- Are laboratory results reported to the district within 7 days of specimen receipt?

Yes ☐ No ☐

2- Does the district conduct review meetings for measles surveillance?

Yes ☐ No ☐

3- How and how often are surveillance data sent to state?

a) Telephone Weekly ☐ Monthly ☐ Quarterly ☐ Other/ specify ☐

b) Fax Weekly ☐ Monthly ☐ Quarterly ☐ Other/ specify ☐

c) Mail Weekly ☐ Monthly ☐ Quarterly ☐ Other/ specify ☐

d) Handover reports Weekly ☐ Monthly ☐ Quarterly ☐ Other/ specify ☐

H- Infrastructure and Data Security

1- Does the district have a car available for supervision? Yes ☐ No ☐

2- Does the district have a computer for measles surveillance? Yes ☐ No ☐

I- District Surveillance Performance Indicators.

1- Does the district analyze it surveillance data

Yes ☐ No ☐

2- If yes check if surveillance monitoring charts of measles cases by months, age, vaccination status and indicators.

Yes ☐ No ☐

3- Using surveillance reports or laboratory data, complete the table for district surveillance performance indicators for the past 3 years (2011 - 2013):

	Indicator(80% WHO standards)	2011	2012	2013
A	% of sites reporting weekly			
B	% of cases* notified within <48 hours of onset of rash			
C	% of cases investigated within <48 hours of notification			
D	% of cases with adequate specimen			
E	% of cases with laboratory results within 7 days			
F	% of confirmed cases with sources of infection identified			

Annexe (2)

Assessment of Measles Elimination's Criteria in shendi & Almatama localities

In River Nile State, Sudan 2012-2015

Questionnaire of Health facilities level

Date / / 20 localities .... District.....................................

Health facility..................... Name of data collector..............................

1. Surveillance priority level

a) High ☐ B) Medium ☐ C) Low ☐

2. Availability of assigned focal persons

a) Not available ☐ b) Available but no backup person ☐ c) Available with backup persons ☐

3. Dose the Measles focal person knows the standard measles case definition

Yes ☐ No ☐

4. Dose the Measles focal person know how to report the suspected cases

Yes ☐ No ☐

5. Do you know the purpose of measles active search?

Yes ☐ No ☐

6. Do you conduct any link with the community regard community active search?

Yes ☐ No ☐

7. If yes, is it documented?

Yes ☐ No ☐

8. How many days need to receive the lap result? (Within)

a) one week ☐ b) 2 weeks ☐ c) 3weeks ☐ d) > 3 weeks ☐

9. Did you receive supportive supervision last month?

Yes ☐ No ☐

10. If yes, dose the action point noted and achieved?

Yes ☐ No ☐

11. How often do you receive the national measles updates/notifications/recommendations/year?

a) Once ☐ b) twice ☐ d) more than 3 time c) never ☐

12. Availability of documents:

No	Item	Yes/No	(Completed) Yes/No	Observation
1	Surveillance reporting forms			
2	Reported cases folder			
3	Line listing			
4	Field book for measles			
5	Supervision logbook			
6	Notification report			
7	Sampling kid			
8	Poster of case definitions			
9	Community education material			

Annexe (3)

Assessment of Measles Elimination's Criteria in shendi & Almatama localities

In River Nile State, Sudan 2012-2015

Measles Immunisation Survey

Date: / /20 **cluster No** ☐ **child No** ☐

1. **age in month** ☐
2. **Sex :-** male ☐ female ☐
3. **Resident** : -

   a) Rural ☐ b) Urban ☐ c) semi urban ☐ d) slum ☐

4. **Mother education:-**

   a) Illiteracy☐ b) primai☐ c) secoi☐ d) high ed☐on

5. **Number of child :--(9 to 18 month)**

   a) < 2 children☐ b) 2 – 3 children ☐ c) 4-5 children ☐ d) > 5 children ☐

6. **Card availability:-**

   Yes ☐ No ☐

7. **If No, reasons** :-

   a) Lost ☐ b) damage ☐ c) don't received ☐

8. **Vaccination status: First dose (9 month)**

   Yes ☐ No ☐

9. **Reasons if No (put the number below)** ☐
10. **Vaccination status: Second dose (** **)**

    Yes ☐ No ☐

11. **Reasons if No (put the number below)** ☐
12. **Source of immunisation**

    a) HC ☐ b) HOS ☐ c) OUT ☐ d) MOB ☐

SIAs vaccination status (child over 9 month to 15 years):-

13. Did the child > 9 month receive the measles dose during last ASIs?

Yes ☐ No ☐

14. Reasons if No (put the number below) ☐

Reasons for immunization failure

1. Unaware of need for immunization
2. Unaware of need to return for 2nd or 3rd dose
3. Place and/or time of immunization unknown
4. Fear of side reactions
5. Wrong ideas about contraindications
6. Place of immunization too far
7. Time of immunization inconvenient
8. Vaccinator absent or vaccine not available
9. Long waiting time

Annexe (4)

Assessment of Measles Elimination's Criteria in shendi & Almatama localities

In River Nile State, Sudan 2012-2015

Clinicians Questionnaire

1- **Gender** : A) Male ☐ B) Female ☐

2- **job Title** : A) House office ☐ B) Medical officer ☐ C) Specialist ☐

3- **Work site** : A) Hospital ☐ B) Health Centr ☐ C) Privet clinic ☐ D) Have 2 work sites ☐

4- **Years of experience**: A) 1-3 years ☐ B) 4- 6 years ☐ C) more than 6 years ☐

5- **Job status** :

A) Fixed government ☐ B) private employee ☐ C) temporary government ☐

6- **Did you have training in measles surveillance before**?

A) Yes ☐ B) No ☐

7- **If your answer yes, when?**

A) Before 3 months ☐ B) before 6 months ☐ C) last years

8- **Do you know measles case definition?**

A) Yes ☐ B) No ☐

9- **If your answer yes, please write in brief?**

....

10- **Do you know the measles reporting system**?

A) Yes ☐ B) No ☐

11- **If your answer yes, please write in brief?**

....

....

12- **Did you report any case of measles before? (Report to the EPI surveillance system)**

A) Yes ☐ B) No ☐

13- **If your answer yes, did you received any feedback from EPI surveillance system?**

B) Yes ☐ B) No ☐

14- **Do you have any of flowing measles surveillance materials in your office?**

A-Measles surveillance manuals. B- Measles case definition posters.

C-Measles case investigation sheets. D- Kits for specimen collection

Thank you for your collaboration to complete this questionnaire .**optionally**, write you E-mail address below to send you a package containing measles elimination information.

E-mail Address: ....